April 17, 1961

Aviation Week and Space Technology

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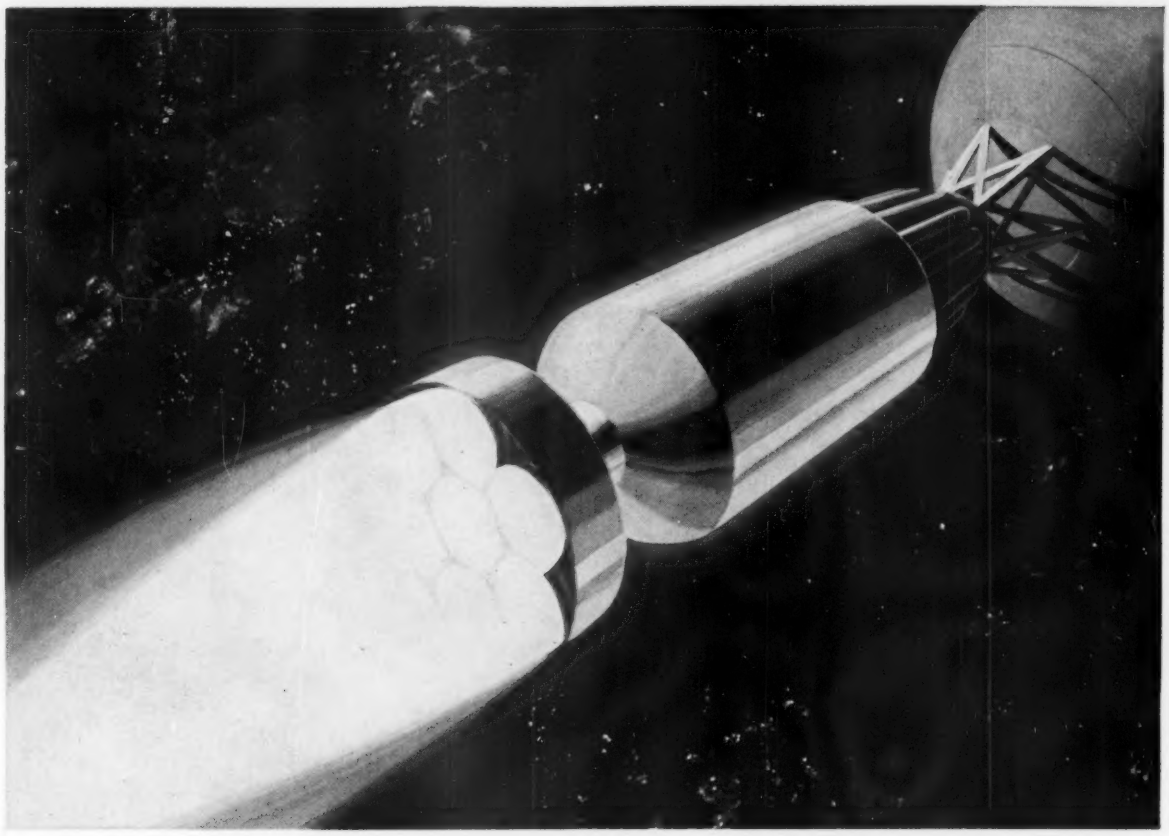
Missile Defense Dominates PMR Efforts

ITT's Vortac Antenna Rotating Assembly

NUCLEAR ROCKET PROPULSION AT AEROJET-GENERAL



Nuclear rockets, with a performance capability nearly twice that of the highest-specific-impulse chemical rockets, have been of major interest to Aerojet-General for several years.

Exploratory studies were initiated by Aerojet in 1955 to ascertain the feasibility of nuclear rockets, and the technical advances required to develop a successful nuclear propulsion system were determined. This work at Aerojet has undergone continuous expansion under government and company sponsored programs. Included are: preliminary design of engines and vehicles, simulated nuclear engine tests, radiation hazards research, analog computer system design (to simulate nuclear rocket operation), nuclear test facility construction, and the design, development, testing, and manufacture of reactors.

These programs have resulted in significant progress toward the development of a practical and reliable nuclear propulsion system. They are based on Aerojet's combined experience in liquid and solid propellant rocketry, nuclear technology, and cryogenics—experience which ensures that the challenge of a new era in propulsion can, and will, be met.

Aerojet-General® CORPORATION

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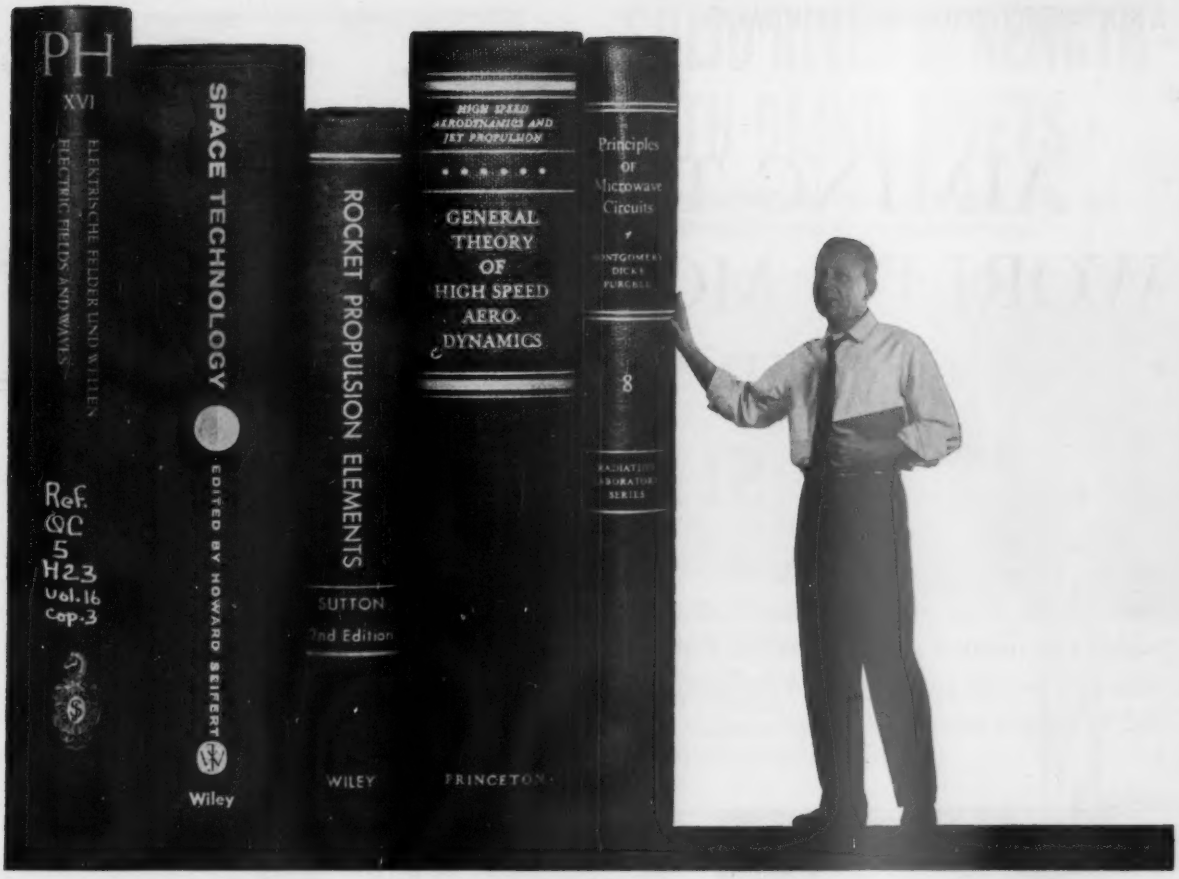

space systems planning and engineering in a unique role

The scientists and engineers of Aerospace Corporation are in the forefront of advanced planning and general systems engineering. Their unique role : critical civilian link uniting government and the scientific-industrial team developing space systems and advanced ballistic missiles. In providing broad scientific and technical leadership to every element of this team, they are engaged in activities spanning the spectrum from formulating new weapons systems concepts to technical supervision of the over-all industry team performing research, development, and test of missile/space systems. Specific activities include investigation of techniques for improving the state-of-the-art in propulsion, structures, guidance, communications and other engineering skills related to missile/space missions; feasibility studies of new weapons systems concepts and preliminary design of promising systems; formulation of development programs; conduct of critical experiments; technical supervision of the development and test program. Men with these backgrounds are invited to write to Mr. George Herndon, Aerospace Corporation, Room 101, P. O. Box 95081, Los Angeles 45, California.

Organized in the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government.

AEROSPACE CORPORATION

A NEW PRODUCT DEVELOPMENT FROM BARDEN

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Hitting a marble placed at the far end of a block-long playground is child's play compared to the performance of an intercontinental ballistic missile. Our ICBMs have proved capable of striking within two nautical miles of a target a quarter of the way around the world. Holding ICBMs on target are inertial guidance gyros that rotate on the world's most precise and dimensionally consistent ball bearings—made by Barden.

Motor-driven gages and recorder provide actual traces to document tolerances held on 20-Millionths bearing parts.

20-Millionths Bearing Tolerances – Maximum	INNER RING	OUTER RING
Roundness (Bore or O.D.)	.000020"	.000020"
Taper (Bore or O.D.)	.000020"	.000020"
Side Runout (with Bore or O.D.)	.000020"	.000020"
Raceway Roundness	.000020"	.000020"
Raceway Parallelism with Side	.000020"	.000020"
Radial Runout	.000020"	.000020"
Parallelism of Sides	.000020"	.000020"

.000020" TOLERANCE BEARINGS

To meet ICBM requirements, 14 ball bearing tolerances had to be reduced to 20 millionths of an inch – a 10-fold advance in the state of the art. Today "20-Millionths" ball bearings are in volume production at Barden – probably the most precise mechanical assemblies ever manufactured in quantity.

NEW GAGING TECHNIQUES

To develop and produce 20-Millionths bearings, Barden devised a radically new approach to production and gaging. For example, a whole new group of special gages had to be designed, utilizing two principles new to high-precision mass production – motor drives and recorded readouts.

EACH BEARING DOCUMENTED

All inner and outer rings are numbered serially, as are the bearings assembled from these parts. When shipped, each bearing is accompanied by documented evidence of compliance with dimensional and functional specifications. A tally sheet backed up by gage traces shows the actual dimensions of inner ring and outer ring of each bearing, all accurate within 20-millionths of an inch. This tolerance, a maximum, is usually bettered, with dimensions often held within 5 or 10 millionths.

PROTOTYPES AVAILABLE

Prototype quantities of 20-Millionths angular contact bearings are now available; .250000" bore, .625000" O.D. in two .000020" calibration groups for bores and O.Ds. For further information, ask for 20-Millionths Booklet TWM.

Barden is a major producer of precision ball bearings for instruments, weapon systems, computers and other high quality equipment.

for reliability...specify

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THE BARDEN CORPORATION, XXX Park Ave., Danbury, Conn. Pioneer 3-9201
Western Office: 3850 Wilshire Blvd., Los Angeles 5, Calif. DUnkirk 5-0034

AVIATION CALENDAR

Apr. 24-27—32nd Meeting, Aerospace Medical Assn., Palmer House, Chicago.

Apr. 25-27—Ninth Annual Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla.

Apr. 26—Session on Air Transport Problems, Society of Automotive Engineers' Pacific Northwest Section, New Washington Hotel, Seattle, Wash.

Apr. 26-27—High Temperature Materials Conference, American Institute of Mining, Metallurgical and Petroleum Engineers, Pick-Carter Hotel, Cleveland, Ohio.

Apr. 26-28—Liquid Rockets, Propellants and Combustion Conference, American Rocket Society, Palm Beach, Fla.

Apr. 26-28—Seventh Region Technical Conference, Institute of Radio Engineers, Hotel Westward Ho, Phoenix, Ariz.

Apr. 27-29—13th Annual Air Meet, National Intercollegiate Flying Assn., Texas A&M College, College Station, Tex.

Apr. 30-May 4—Seventh National Aerospace Instrumentation Symposium, Instrument Society of America, Adolphus Hotel, Houston, Tex.

Apr. 30-May 6—Annual Meeting and News Conference, Aviation/Space Writers Assn., Hotel Commodore, New York.

May 2-4—Electronic Components Conference, Institute of Radio Engineers, Jack Tarr Hotel, San Francisco, Calif.

May 3-5—17th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 3-5—Nuclear Applications in Space Conference, American Rocket Society/Oak Ridge National Laboratory, Gatlinburg, Tenn.

(Continued on page 6)

AVIATION WEEK and Space Technology

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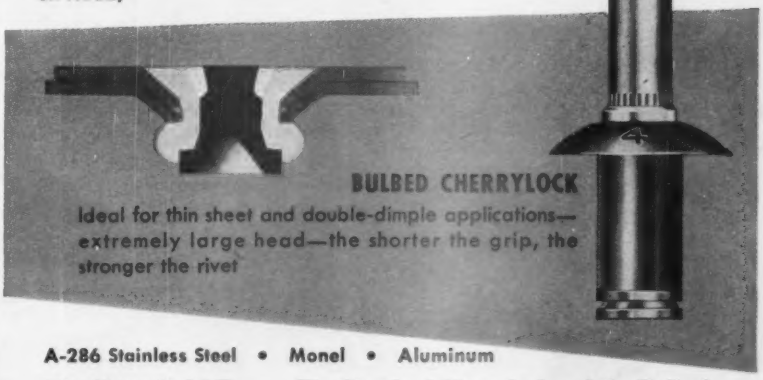
BULBED CHERRYLOCK
Ideal for thin sheet and double-dimple applications—extremely large head—the shorter the grip, the stronger the rivet

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The Cherrylock* Team—The Standard Cherrylock and the Bulbed Cherrylock—offers a blind rivet that installs and performs like a solid rivet. Cherrylock rivets will qualify where you are now using a solid rivet, offering higher joint strength with greatly increased joint reliability under critical loading conditions—fatigue, shake and sonic vibration.

Now Cherrylock gives you a blind rivet that can be used in expensive forgings as well as for joining and attaching sheets.

For technical data on Cherrylock rivets, write Cherry Rivet Division, Townsend Company, Box 2157-C, Santa Ana, California.

*Patent No. 2931532

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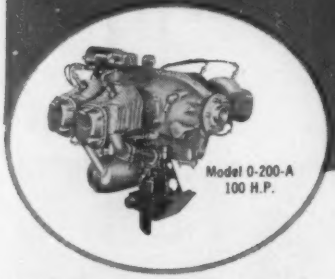
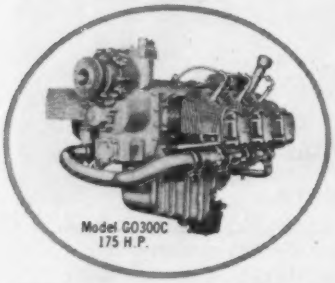
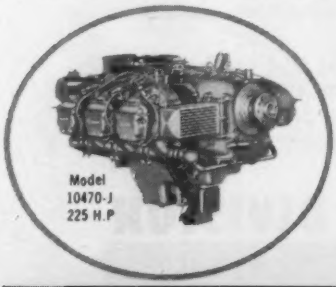


Model O-200-A
100 H.P.

One reason why users of business aircraft show such decided preference for planes with Continental power is the elaborate set-up maintained by Continental Motors to keep such aircraft in the air at lowest cost. Owners know that no matter where they fly —north, south, east or west—there's established Continental service—genuine parts and competent mechanics—close at hand. When it comes to choosing a plane that must pay its way as a business tool, the confidence born of that knowledge is a factor second in importance only to engine dependability itself.



Model GO300C
175 H.P.



Model
10470-J
225 H.P

The men and machines that built your engine originally are best qualified to restore it to like-new condition. Continental's Factory Re-Manufacture backs you with factory knowhow, and precision production machinery, throughout your engine's life. Write for information.

Continental Motors Corporation
AIRCRAFT ENGINE DIVISION
MUSKEGON • MICHIGAN

AVIATION CALENDAR

(*Continued from page 5*)

May 4-5—Second National Symposium, Human Factors in Electronics, Institute of Radio Engineers, Marriott-Twin Bridges Motor Hotel, Arlington, Va.

May 6-9—Fifth Midwest Symposium on Circuit Theory, Institute of Radio Engineers, University of Illinois, Urbana.

May 8-10—Spring Lubrication Symposium, American Society of Mechanical Engineers, Deauville Hotel, Miami Beach.

May 8-10—National Aerospace Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, Ohio.

May 8-12—Annual Meeting, Airport Operators Council, Carillon Hotel, Miami Beach, Fla. (AOC-American Society of Civil Engineers' Joint Seminar, "Increased Capacity of Airport Systems," May 11-12.)

May 9-11—Western Joint Computer Conference and Exhibit, Ambassador Hotel, Los Angeles, Calif.

May 10-12—Spring Meeting, Society for Experimental Stress Analysis, Benjamin Franklin Hotel, Philadelphia, Pa.

May 11—Air Force Office of Scientific Research Lecture and Banquet in honor of the 80th Anniversary of Theodore von Karman, Sheraton Park Hotel, Washington, D. C.

May 12—National Armed Forces Day Dinner, Sheraton Park Hotel, Washington, D. C.

May 12-14—Mid-America Air Fair, Municipal Airport, Wichita, Kan.

May 15-16—Region One Air Traffic Control Assn. Convention, Hotel Bradford, Boston, Mass.

May 15-16—Aviation Fire Safety Seminar and Technical Session, National Fire Protection Assn., Hilton Statler Hotel, Detroit, Mich.

May 15-17—National Symposium on Microwave Theory and Techniques, IRE, Sheraton Park Hotel, Washington, D. C.

May 15-18—20th Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton Hotel, Akron, Ohio.

May 22-24—National Telemetering Conference, Sheraton-Towers Hotel, Chicago, Ill.

May 22-24—Fifth National Symposium on Global Communications, Institute of Radio Engineers, Hotel Sherman, Chicago.

May 26-June 4—24th French International Air Show, Le Bourget, Paris, France.

May 27-30—13th Annual Wright Memorial Glider Meet, Soaring Society of Dayton, Dayton, Ohio.

May 31-June 2—University of Michigan's Seventh Annual Radar Symposium, Ann Arbor, Mich.

June 2-3—12th National Maintenance and Operations Meeting, Reading Aviation Service, Inc., Reading, Pa.

June 13-15—National Joint Meeting, Institute of the Aerospace Sciences and American Rocket Society, Ambassador Hotel, Los Angeles, Calif.

July 25-Aug. 10—International Trade Fair and Aviation Exhibition, McCormick Place Exposition Center, Chicago, Ill.

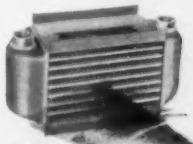
Aug. 22-25—Western Electronic Show and Convention, Cow Palace, San Francisco.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

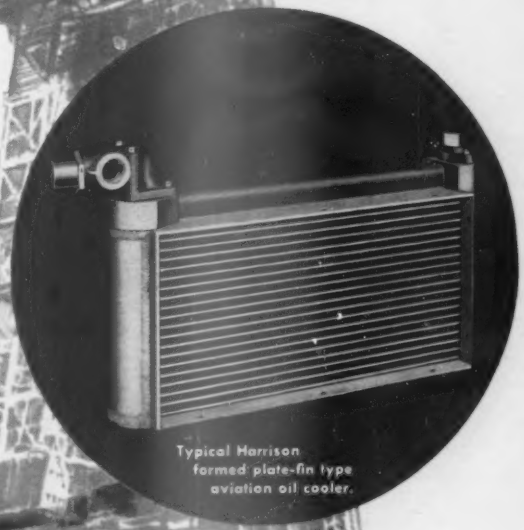
From General Motors...Temperatures Made to Order

GM HARRISON GIVES KAMAN A COOL LIFT !

Where heat is a critical problem, you'll find Harrison on the job! Harrison heat exchangers dependably and efficiently control vital operating temperatures on the most advanced military and civilian aircraft—piston, turbo-prop and turbo-jet powered. That's why Kaman specified Harrison engine and transmission oil coolers for its H-43B Huskie turbine helicopter. Powered by a Lycoming T-53 engine, the Huskie passed the most rigid reliability tests with flying colors. You'll find this same built-in reliability in 15 basic types of Harrison heat transfer construction—a complete line of designs which permits the selectivity that assures the *right* heat exchanger for every application. To save time and money on your temperature control problems, be sure to call in a Harrison Sales Engineer at the design stage.



Harrison heat exchangers—quality products of General Motors Research and Engineering—offer high reliability for aircraft, space and missile applications.



Typical Harrison formed plate-fin type aviation oil cooler.

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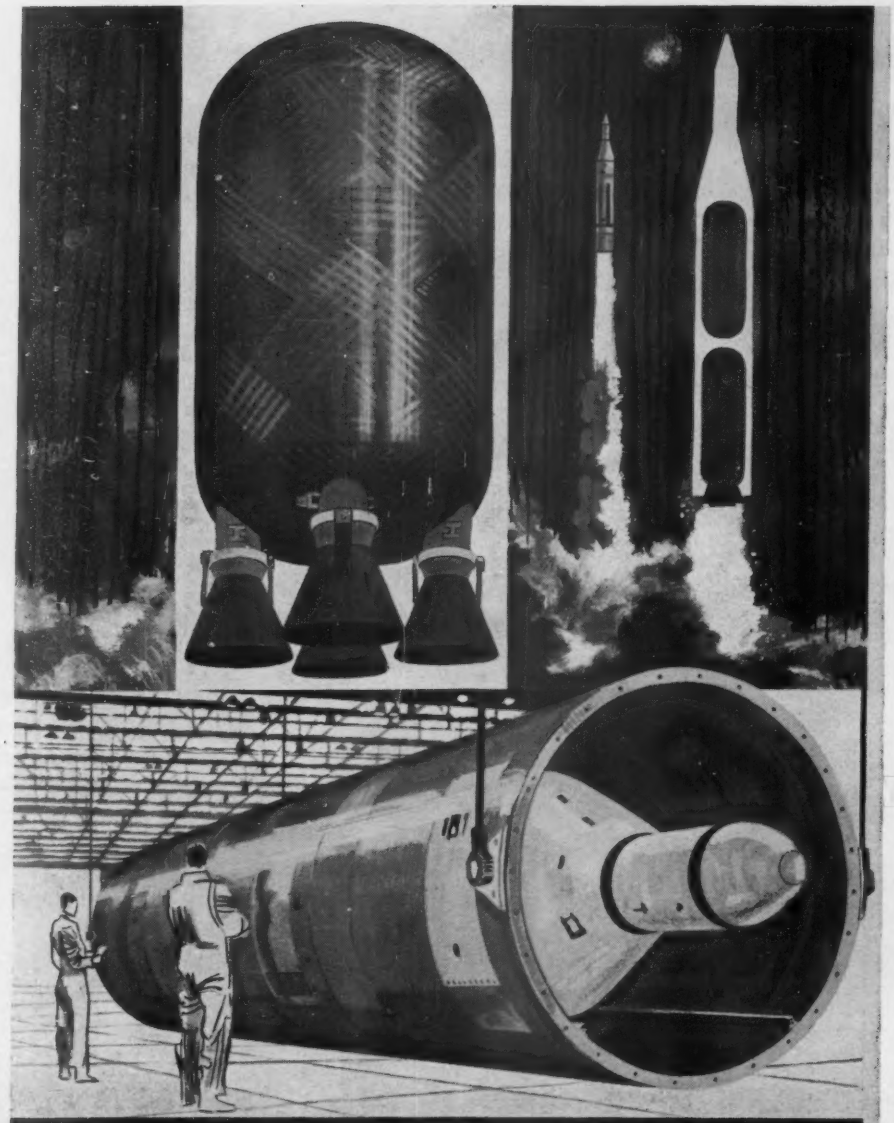

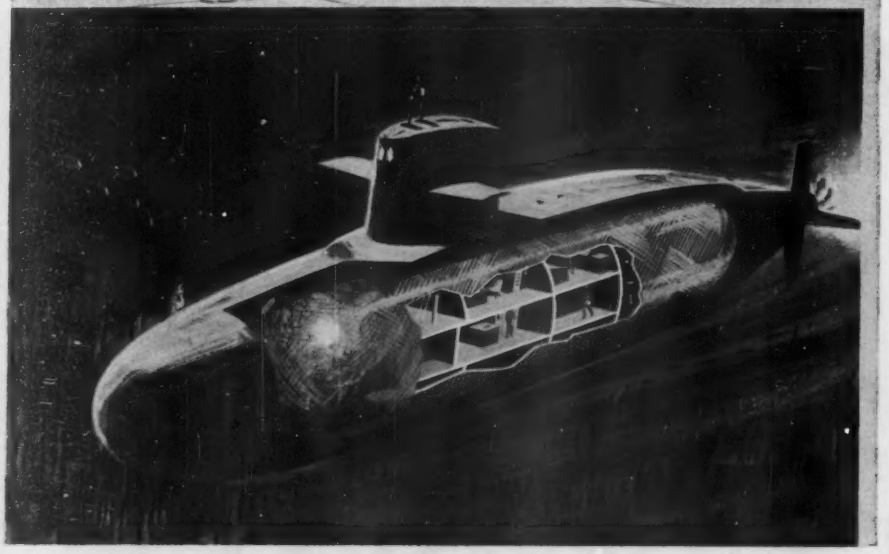

THE WONDER MATERIAL FOR ADVANCED CONCEPTS IS PLASTICS

...AND PLASTICS MEAN ZENITH

The Zenith-developed method of end-over-end filament winding is ideal for advanced concepts for missile cases, rocket motor containers, and deep diving submersibles. A case in point is Zenith's capability of tension-winding cases up to 12 ft. x 85 ft. No other company in the United States can wind cases of this size.

Zenith's technique utilizes glass filaments pre-impregnated with resin to form these structures. During the process the glass is protected by the resin, minimizing the possibility of undetected fracture. This assures more uniformity and reproducibility.

Exact manufacturing quality assurance can be exercised from basic glass filament to completed structure.

Before you seal the design, consider the many benefits of plastics for your projects. Remember, the wonder material for advanced concepts is plastics... and plastics mean Zenith.

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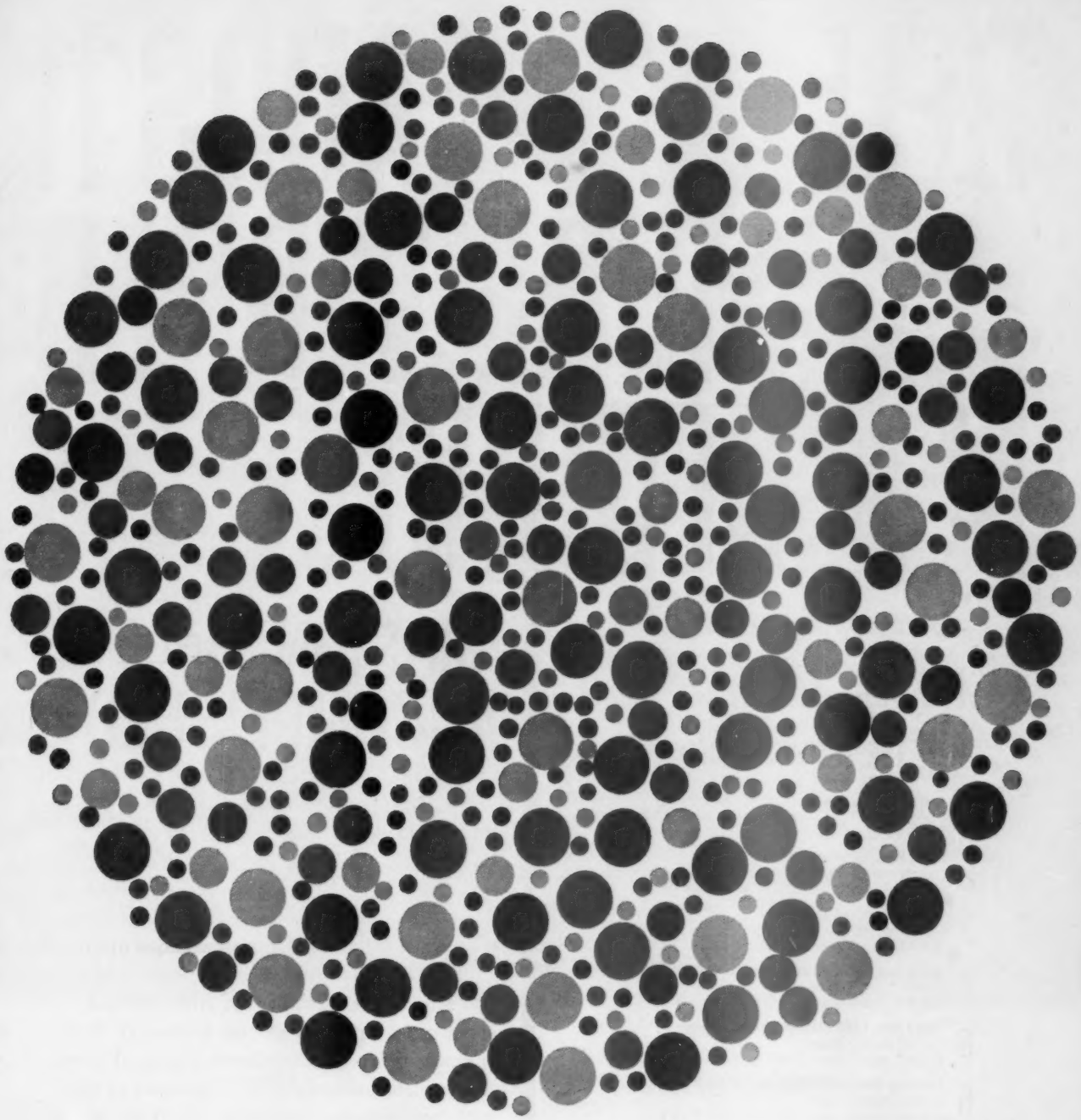
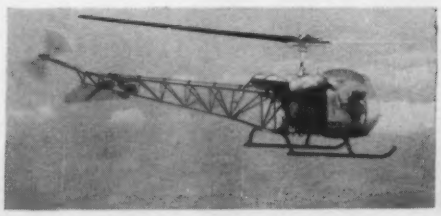


IAI Within the spectrum of contemporary military communications, concealed transmission in the intermediate range has presented a formidable problem. The IAI system for *information acquisition and interpretation,* developed by the Westwood Division of Houston Fearless Corporation, is a major advancement toward its solution. The IAI concept of visual, digital, or speech transmission in this problem range establishes entirely new standards for reliability, cryptographic safety and concealment. Westwood researchers are probing the entire realm of electromagnetic and acoustical phenomena as they seek out even more advanced techniques, propagation mechanisms, and radiation devices in all ranges and modes of communication for tactical and strategic reconnaissance, or for general scientific purposes. Inquiries regarding the IAI system will be given immediate attention. Scientists and engineers wishing to join this advanced program will receive every consideration. Westwood Division, HF Houston Fearless Corporation, Los Angeles 64.

BELL  ADDS 11 MORE WORLD RECORDS

Bell Helicopter team now claims 19 world records . . . takes lead from Russian MIL team!

THE 11 NEW RECORDS*

1. **Speed Run, 100 kilometers (62.14 miles)**
   Current record—101.14 mph—held by Russian KA-15
   Bell 47J-2 record claim: 107.08 mph (Class E. 1. c)
2. **Speed Run, 100 kilometers (62.14 miles)**
   Current record—70.36 mph—held by Czechoslovakian H.C.2
   Bell 47J-2 record claim: 104.61 mph (Class E.1.b.)
3. **Distance in closed circuit**
   Current record—None
   Bell 47G record claim: 631.436 miles (Class E.1.b.)
4. **Speed Run, 500 kilometers (310.70 miles)**
   Current record—None
   Bell 47G record claim: 73.985 mph (Class E.1.b.)
5. **Speed Run, 1,000 kilometers (621.40 miles)**
   Current record—None
   Bell 47G record claim: 73.641 mph (Class E.1.b.)
6. **Non-stop distance, straight line (Without Payload)**
   Current record—None
   Bell 47G record claim: 729 miles (Class E.1.b.)
7. **Speed Run, predetermined point-to-point**
   Current record—None
   Bell 47G record claim: 102.392 mph (Class E.1.)
8. **Speed Run, predetermined point-to-point**
   Current record—None
   Bell 47G record claim: 102.392 mph (Class E.1.b.)
9. **Altitude without payload—Female**
   Current record—14,760 feet—held by Russian Mil-1
   Bell 47G-3 record claim: 19,406 feet (Class E)
10. **Non-stop distance, straight line (Without Payload)—Female**
    Current record: 214.129 miles—held by Russian Mil-1
    Bell 47G-3 record claim: 404.36 miles (Class E)
11. **Speed Run, predetermined point-to-point—Female**
    Current record—None
    Bell 47G-3 record claim: 91.26 mph (Class E)

Of the other eight world records held or claimed by Bell helicopters, seven were set by the HU-1 Iroquois in 1960, one by the 47D-1 in 1952.

*Pending official verification by the Federation Aeronautique Internationale.

MISSION BELL ACCOMPLISHED

Today, Bell claims 19 official world records, more than double the number held by all other U. S. makes combined, and more than any other nation. Eighteen of these marks were set during the past nine months! And, each Bell record was established, not by an experimental ship, but by a *production-line* model . . HU-1 and Model 47 (H-13) series . . military and commercial products of the aggressive Bell engineering-manufacturing-management team. These accomplishments are a measure of the high performance standards by which Bell is known to military and commercial users . . evidence of Bell's undeniably superior capability to meet the helicopter performance demands of modern military planning.

For recognized world leadership in flight performance, look to

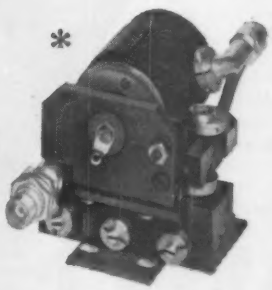
BELL HELICOPTER COMPANY FORT WORTH, TEXAS

A DIVISION OF BELL AEROSPACE CORPORATION • A textron COMPANY

Goe, and catche a falling starre

(John Donne, 1572-1631)

By replacing erratic, expensive magnetrons with a *pulsed triode output stage**, the General Dynamics/Electronics Model 702 C-Band Transponder makes a major contribution to the art of target enhancement . . . increases the reliability of tracking systems. Output—a solid 1 Kw, answering precision C-Band tracking radars such as the AN/FPS-16 and AN/MPS-26. The 702 is a tough little ten-pounder that measures 7⅛ x 8¼ x 3⅝ overall, including its own power converter. It draws a skimpy, weight-saving 30 watts from an external 28-volt DC power source. It is completely transistorized, except for the transmitter and local oscillator. For stellar environmental performance, circuits are modularized and form a single, rigid, rugged unit. Thirty-eight codes can be decoded. Equipment like the Model 702 Transponder is a noteworthy achievement of General Dynamics/Electronics space electronics program. If you're interested in the 702 . . . or in other aspects of space transmission, command control or tracking . . . write for the illuminating facts.



Engineers and scientists interested in challenging opportunities are invited to send résumés to Manager, Engineering Employment.

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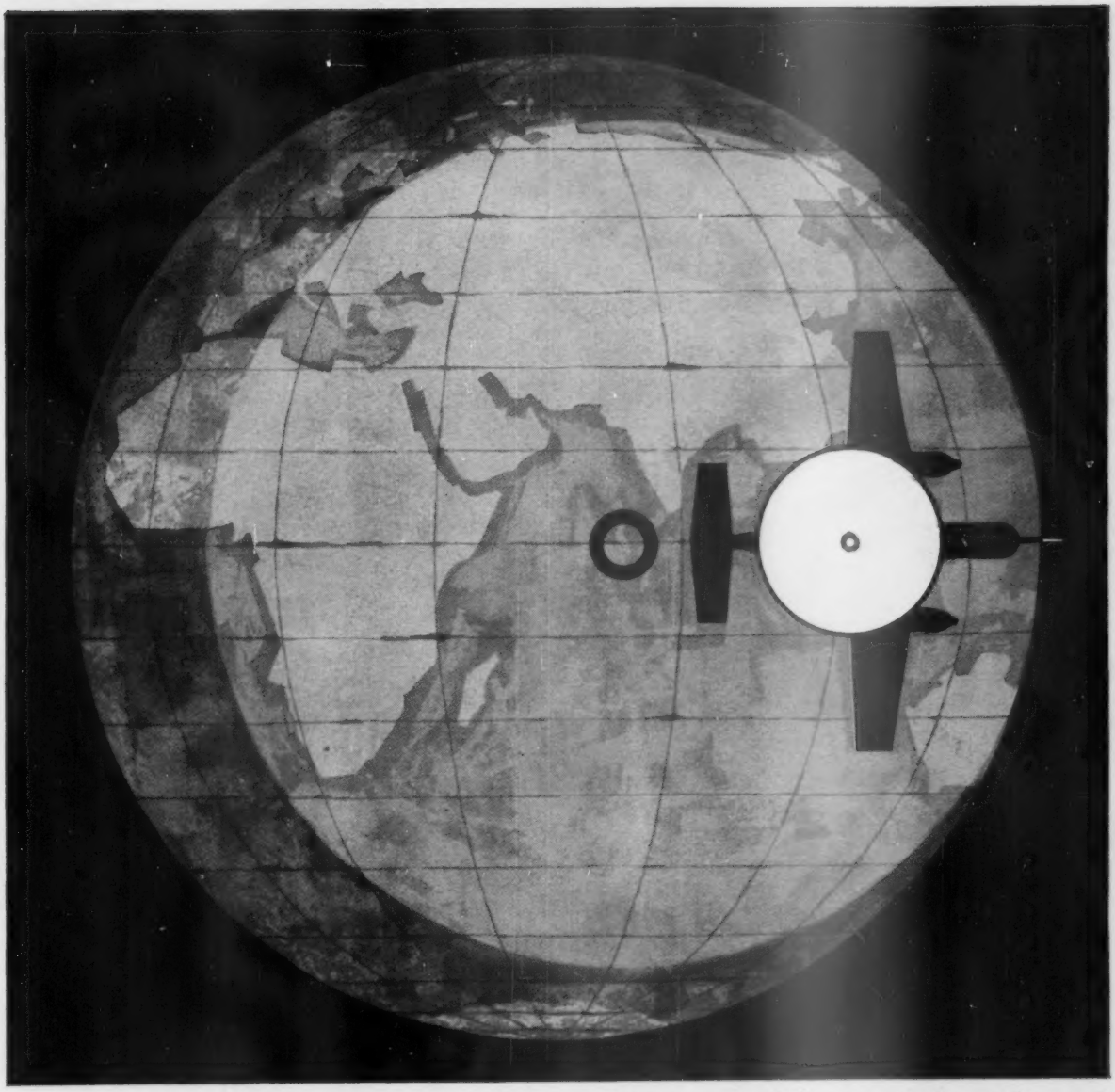

Brunswick Rotodomes - New Eyes and Ears of the Fleet!

Grumman Hawkeye carrier-based A.E.W. aircraft with a Brunswick-built rotodome gives new early warning capability to the Navy.

The Dalmo-Victor Division of Textron Inc. assigned Brunswick the task of fabricating the newest and most sophisticated of rotodomes. Brunswick's vast experience in fabricating large plastic-metal structures of sandwich construction assured the customer and the Navy of receiving a completely reliable product.

This large, complicated structure is another example of Brunswick's capability in the field of reinforced plastics and metal honeycomb. Whether the requirement be for a small structural unit such as a missile radome operating at high frequency, a large composite structure such as the rotodome, large reflectors or ground domes, you can count on Brunswick's project experience to accomplish your most difficult assignments.

In addition, Brunswick offers imaginative scientists and engineers to provide a searching approach to materials and fabrication techniques and electronic know-how. Complete testing and quality control facilities assure the success of all programs.

Interested engineers will find it rewarding to discuss career futures with Brunswick.

MAKES YOUR IDEAS *WORK*

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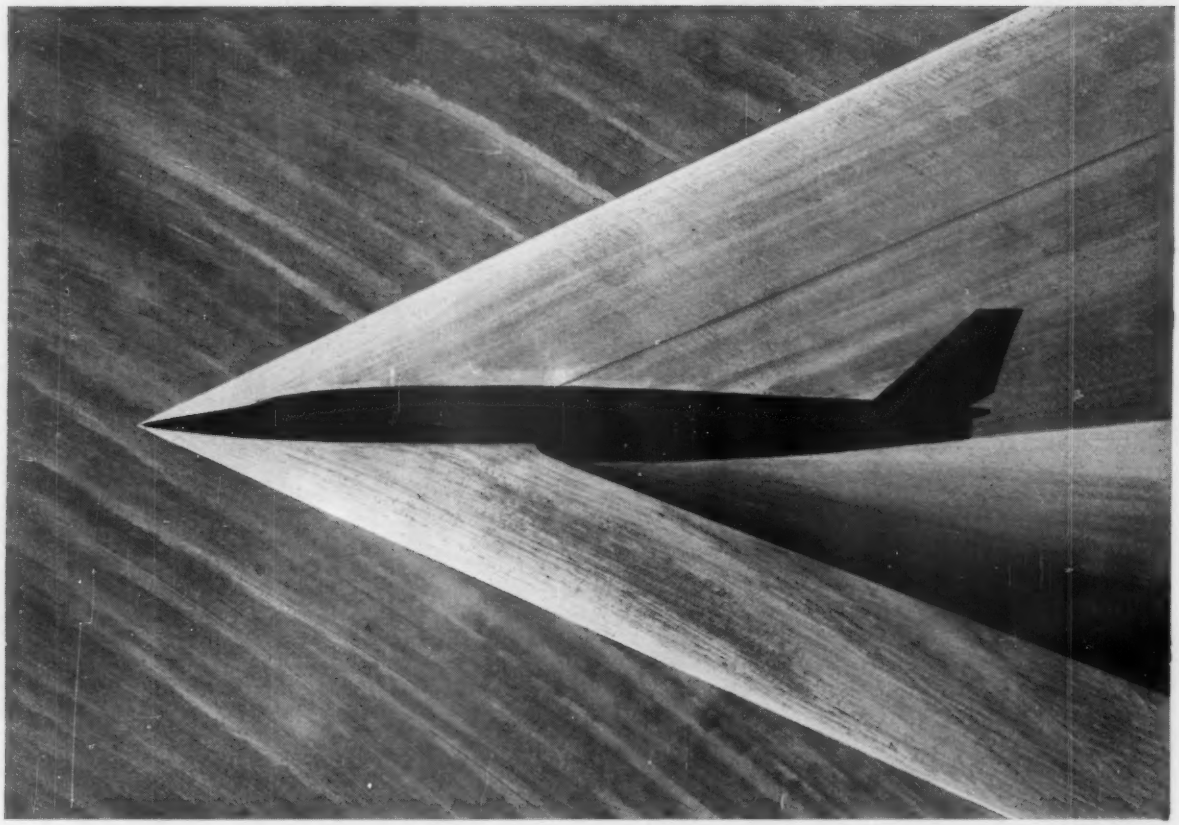


Mach 3 Technology

Designing a plane to ride triple-sonic shock waves like a surfboard

For years manned aircraft have been imprisoned in their own V-shaped shock waves which were created when traveling at high speeds. These waves caused a tremendous increase in drag, and a consequent heavy penalty had to be paid in fuel consumption, limiting the range of supersonic flight.

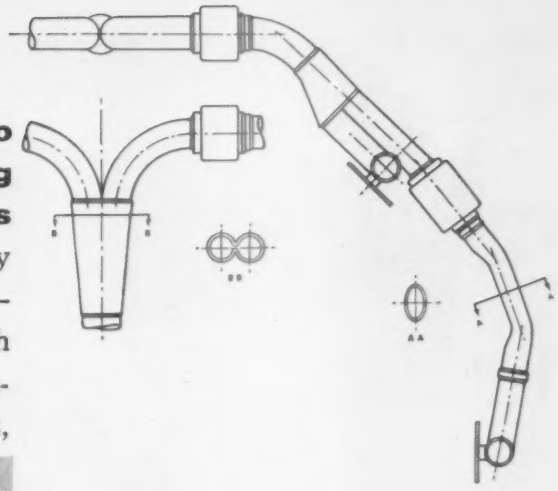
This was the problem facing the engineers at the Los Angeles Division of North American Aviation as they designed the Mach 3 B-70 Valkyrie bomber for the Air Force. The answer lay in an entirely new principle of aerodynamic science which had been discovered by the former National Advisory Committee for Aeronautics. This principle was that, properly designed, a triple-sonic aircraft could actually ride its own air patterns somewhat like a surf-rider on the crest of a wave.

North American engineers set out to design a wing and undersurface which would make use of this aerodynamic principle. The result was a delta wing shaped in the V which would be made by air waves when flying at Mach 3 speeds. The design was highly practical. With this new design advance, there now exists a means for manned aircraft to not only reach triple-sonic dash speeds, but to cruise for intercontinental distances at them.

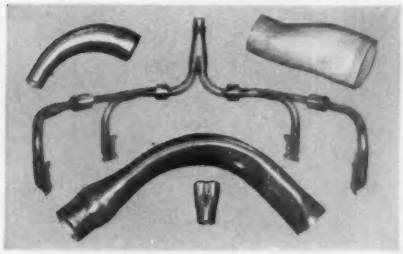
Advanced design achievements like this will help sustain America's leadership in aircraft by making possible the Mach 3 B-70 and future commercial aircraft.

Builders of the B-70 Valkyrie

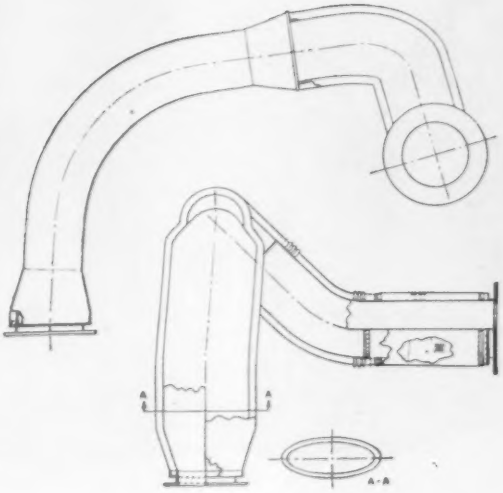
THE LOS ANGELES DIVISION OF **NORTH AMERICAN AVIATION, INC.**

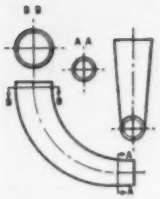


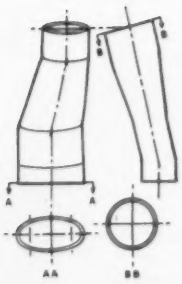
Conforming to intricate and demanding envelope requirements is a problem that constantly harasses ducting designers—coming as it does on top of such considerations as pressure, temperature, vibration, weight,



and flexibility. However, these problems can be solved for you economically and expeditiously, if you utilize the readily available ducting engineering service of your Flexonics representative. Then you will receive reliable products designed specifically to your requirements, because Flexonics techniques permit the precision forming of multi-plane assemblies and constant-area section changes to meet your most exacting envelope limitations.







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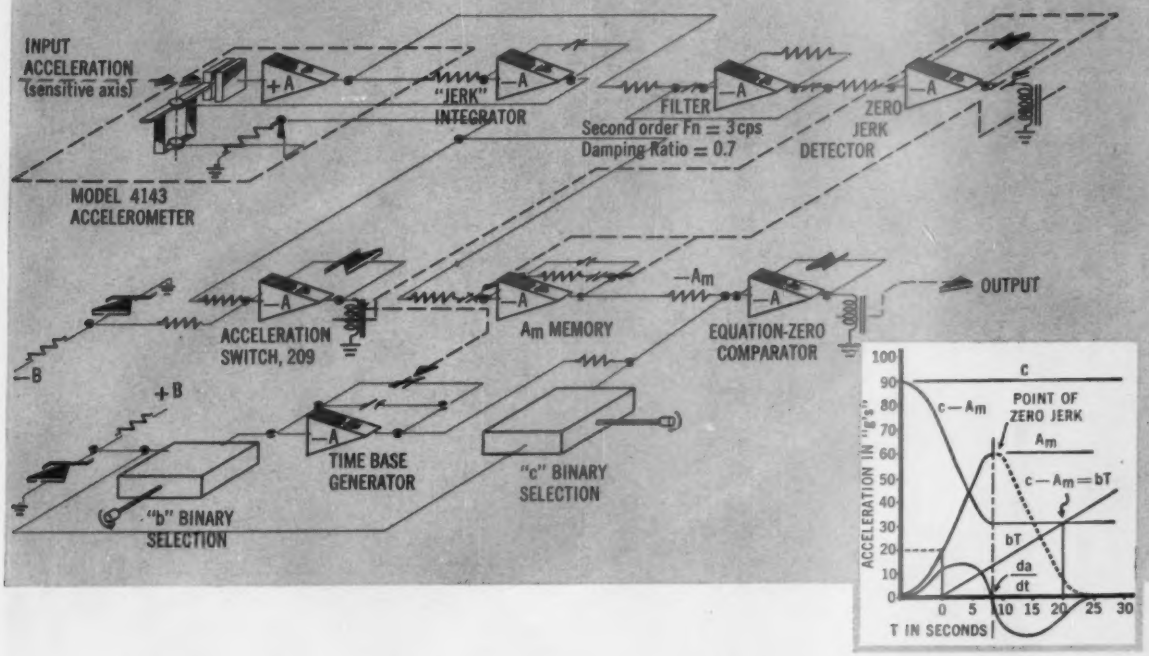
CECO® SYSTEMS CONTROLS

Functional Diagram of Donner Accelerometer Timer Switch. Basically an airborne computer designed to solve a specific equation, this Donner device consists of a force balance accelerometer, whose output feeds to a jerkmeter for determination of peak acceleration (jerk (da/dt) is the first derivative of acceleration). From the jerkmeter the signal passes through a filter and to a zero jerk detector which closes a switch at the peak acceleration. Other units in the computer are a peak acceleration memory, a 20 g acceleration switch which starts a time base generator and prevents the zero jerk detector from operating before a correct solution is possible, "b" and "c" selection binary units allow 64 values of "b" and "c" to be selected within the operating range, and an equation zero comparator which algebraically sums the output of the maximum acceleration memory circuit, time base multiplied by "b" and "c" circuit to close the relay output when $bT = c - A_m$. The curve below illustrates the equation and the fact that peak acceleration occurs at zero jerk.



How to Solve a Flight Equation

New Donner Airborne Analog Computer solves equation $bT=c-A_m$

where b = predetermined constant, T = time in seconds, c = predetermined constant, and A_m = peak acceleration achieved.

Causing a missile event to occur at just the right time and place in space is one of the critical problems faced by the control engineer. The programming device must be light, accurate, strong and, above all, reliable in severe environments.

When Donner engineers were confronted with this problem, they came up with a fixed purpose airborne analog computer known more specifically as an acceleration summing switch. The summing switch is a "thinking" device which responds to a particular environmental stimulus. Thinking for the vehicle, the switch measures time, multiplies it by a preset constant, equates the product to the memorized peak acceleration subtracted from a constant and when the sum reaches a predetermined value, actuates a relay. Such a point occurs during decreasing acceleration and is dependent on the magnitude of peak acceleration.

In solving this problem, Donner engineers combined their experience with computer techniques and servo force balance accelerometers. The device illustrated is all solid state.

Acceleration Summing Switch. This remarkable small computer is approximately 4" high and 2½" across. The two knobs on the top are used to set in "b" and "c" constants of the equation.

39

COMPLETE TECHNICAL INFORMATION AVAILABLE
If you would like more information about this interesting application of computer and transducer techniques, our Mr. Stephen P. Cuff has prepared a technical discussion which he will be happy to send along. Please write Mr. Cuff at Donner Scientific. Dept. 09

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MOBILITY BREAKTHROUGH!

FLEX WING* Recovery of missiles and rockets such as the 60-ton Saturn booster... re-entry of space vehicles at low acceleration... pin-point delivery of air-lifted military equipment, supplies and personnel—these are just a few of the multiple applications for Flex Wing, the newest development being pioneered by Ryan. ■ The Flex Wing embodies extensive advance design and development work by Ryan based on the flexible wing research accomplishments at National Aeronautics and Space Administration's Langley Research Center under direction of Francis M. Rogallo. ■ A Ryan Flex Wing full scale flying test bed is now undergoing extensive flight testing. The wing of this manned test vehicle consists of a flexible, tough, very thin membrane attached to a rigid keel and two leading edge members. Simple in design, more stable, and easier to control than a glider or parachute, the Flex Wing principle can be applied to manned or unmanned, powered or unpowered vehicles. Already Ryan has received contracts from NASA (Saturn booster recovery), Army (logistic vehicle test program) and reconnaissance drones for surveillance and support of combat landing teams. ■ Development of the flexible wing concept is another example of Ryan's advanced engineering capabilities in Space Age technologies. Ryan Aerospace, Division of Ryan Aeronautical Company, San Diego, California.

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April 17, 1961

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COVER: Rotating assembly of Vortac antenna being produced at International Telephone and Telegraph Corp.'s Federal Laboratories in Nutley, N. J., is inspected during final assembly. Supervisor is checking alignment of parasitic elements (fine-gage wires) on the Vortac antenna's rotating assembly. Heat lamps underneath are used in curing the epoxy used to affix the elements to the glass-fiber cylinder. ITT is a major supplier for Federal Aviation Agency's Vortac system.

PICTURE CREDITS

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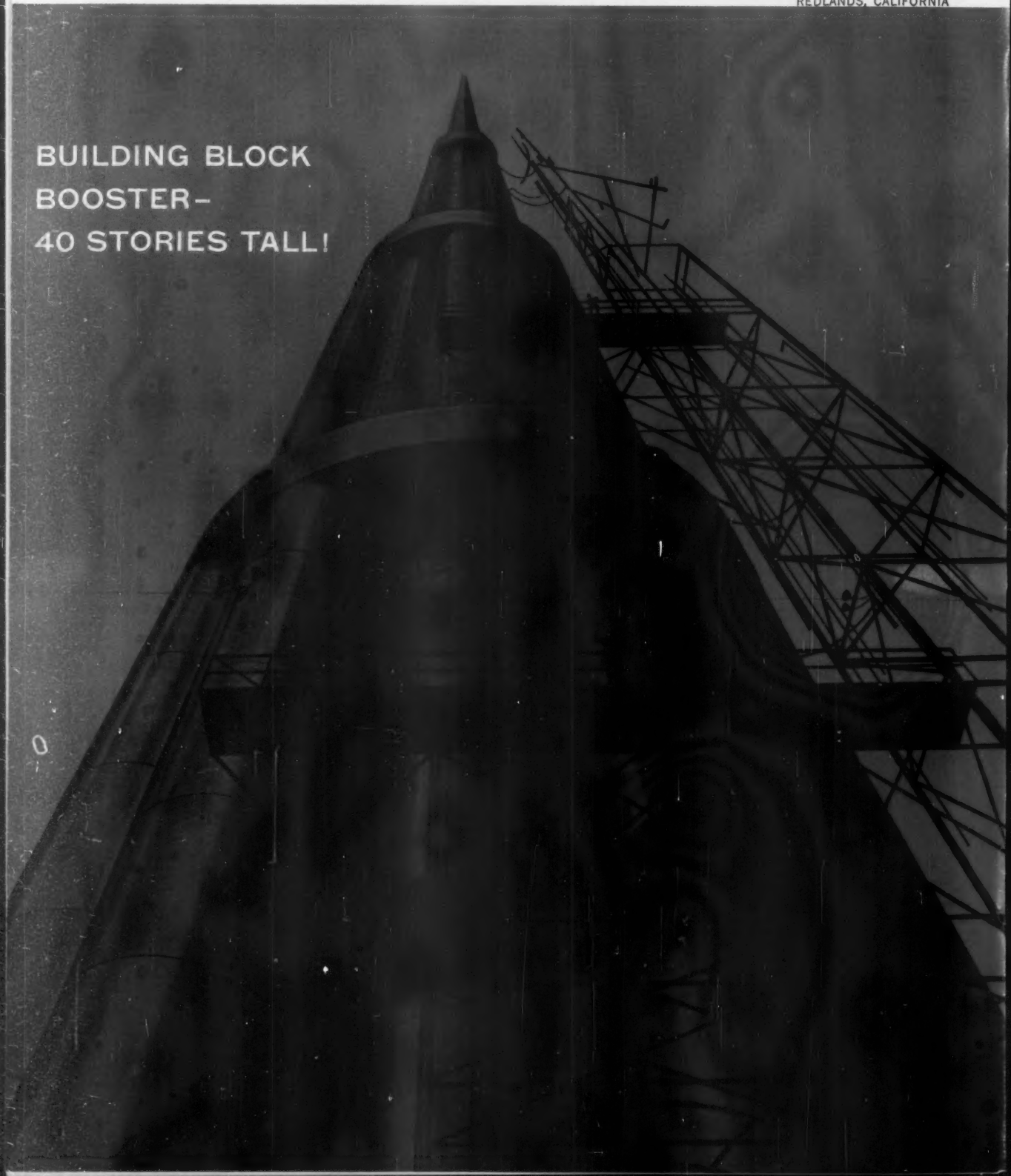
This gigantic GCR-proposed solid propellant booster is made up of easy-to-haul segments that simply would be bolted together at launch site. It could put a 250,000-pound space station in orbit—or send a 60,000-pound manned spacecraft to the moon. It can be developed, built, tested, assembled, maintained, and operated for a small fraction of the cost of a comparable liquid system—yet it is much more reliable. It can be operational by 1967—if we start now. Smaller solid boosters—able to orbit 30,000 pounds—can be available by 1964. **GRAND CENTRAL ROCKET COMPANY**

REDLANDS, CALIFORNIA



EDITORIAL

First Man in Space

Less than 1,300 days after the space age began Oct. 4, 1957 with the first Soviet satellite in orbit, the first man has orbited through space and made a successful return to earth. This is indeed a significant milestone in man's long struggle to master his environment. No American can help feeling a twinge of regret that it is a Russian name—Maj. Yuri Gagarin—that will be chiseled on this milestone, and not one of our countrymen. The nation that was able to carve the name of the Wright brothers on the granite of Kitty Hawk as the first men to achieve powered flight successfully should also look deep into its national soul and ask why we have lost this leadership in the extension of manned flight.

There are many similarities between Maj. Gagarin's historic orbit of the earth and the first lifting of Orville Wright off the sands of Kitty Hawk. Only perceptive observers were able to see the eventual significance of both events when they happened. Just as there were skeptics who for decades doubted that the "flying machine" would have any commercial or military significance, so there are conservative scientists, many of them still sitting in seats of honor, who will denigrate the first manned space flight as foretelling little significance for the future.

But just as those first short flights at Kitty Hawk spawned the tremendous influence of aviation on our civilization of the past 50 years, so does Maj. Gagarin's single orbit of the globe portend an equally significant influence for the inhabitants of this world in their knowledge and use of the infinite space that surrounds them.

For this nation, it is another blow to our national pride and international prestige in a series of setbacks that began with the first Sputnik and has continued through the first moon probes, the first Venus probe and the first recovery of living animals from orbital flight. It is alarming to see that our national leadership, regardless of the change of party in control, still remains pleasantly anesthetized to these painful episodes in the history of our times. We sense the same platitudes emanating from official sources, the same lack of urgency about our own space programs and the same unwillingness to make maximum use of our scientific and industrial resources in an attempt to end this futile stern chase of the Soviets.

It is becoming more and more evident that there is a wide gulf between campaign oratory and executive responsibility. There has been precious little indication that President Kennedy really understands much of the significance of the space race or really intends to do much about improving this nation's capability.

The responsibility for this nation's losing the man-in-space race certainly does not rest with President Kennedy and his advisers, but it will not be long before other Soviet achievements will continue to emphasize the futility of our chase philosophy. Then the onus will be inescapably theirs.

The Soviets' victory in successfully orbiting and recovering the first man in space cannot be blamed entirely on the "booster lag" which has now become the favorite official cliche to explain away all of the deficiencies of our national space program. From all available evidence, it appears that the U.S. and USSR came to the starting mark in the man-in-space race about the same time—roughly the summer of 1958, about nine months after Sputnik I.

It is true that the Soviets' superiority in being able to design for a 10,000-lb. space vehicle gave them substantial advantages over the 2,300-lb. weight limit rigidly imposed on the Mercury capsule because of the wide disparity in booster power available in the contending camps. The time required to miniaturize all Mercury capsule equipment and the difficult decisions over what to omit from it were problems the Soviet technicians did not have to face.

For a variety of reasons, the Mercury program was not laid on as solid a bioastronautics foundation as was the Soviet effort. Their work with animals and other forms of life in both ballistic and orbital shots gave them far more data than the few U.S. space biology experiments that were authorized. And we doubt that the Soviet man-in-space team was hampered by a constant stream of skepticism over both the techniques and purposes of their goal, such as the Mercury personnel endured from U.S. savants who had not one iota of specific contact with the program as it progressed.

As it looks now, the Mercury project could get its first astronaut into orbit shortly before the end of the year. We expect there will be some shouts to scrap this project now that the Soviets have scored a first. Nothing could be greater folly. We will badly need the data from the Mercury project as the foundation for future manned space flight projects, including the military Dyna-Soar and Aerospace Plane, as well as NASA's Apollo and other projects looming even farther out on the technical horizon. We can hardly expect to get this data from the Soviets.

Maj. Gagarin's flight proved that it is possible for man to survive orbital space flight and exercise most of his basic functions during such flight. Now the major task will involve extending the range of man's useful functions in space flights of various types—including landing on other planets and deep space exploration, as well as work in the orbital ranges below the Van Allen belts.

Even though it is possible for the Soviets to put more of their cosmonauts into space flights of increasing duration and variation before the first U.S. astronaut makes the first attempt at orbital flight, we must guard against a slow-down or scuttling of this program.

The role of man in space has just begun, and the race for its ultimate rewards is far from run. Again we have come off slow from the mark and are lagging on the first lap. But this nation has the ability to catch and surpass the Soviets before this race is fully run if it can only develop the determination to do so in its top leadership.

—Robert Hotz

To recall a bullet 12,000 miles away

requires Motorola systems reliability

THE B-70 M&TC major system management contract places in the hands of a single contractor, Motorola, an unprecedented responsibility: positive recall of a Mach 3, nuclear deterrent force. At speeds over 2,000 mph – faster than a rifle bullet – crew and aircraft safety, as well as mission success, demand integration of myriad electronic functions with simplified controls and displays. ☆ The integrated M&TC system includes the functions of world-wide command communications (LRR) linked to the SAC Command Network; line-of-sight, short-range communications (SRR); improved tactical air navigational aids (TACAN); air-by-air IFF; air-by-ground IFF; aerospace ground support equipment (AGE); air-to-air rendezvous equipment; instrument landing system (ILS); and crew intercommunications. ☆ Motorola's role as a major electronic system contractor for the B-70 Valkyrie's Mission and Traffic Control typifies its systems manage.nent capabilities. Detailed information is available on request.

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WHO'S WHERE

In the Front Office

Arthur H. Rude, board chairman, Aerojet-General Corp., Azusa, Calif. **W. E. Zisch** succeeds Mr. Rude as executive vice president. Also: **Howard P. Mason,** assistant secretary.

Rear Adm. Norman Farquhar Garton (USN, ret.), a director of Greer Hydraulics, Inc., Los Angeles, Calif. Adm. Garton is president of Vought Camera Co.

Wyle Laboratories, Inc., El Segundo, Calif., has elected the following new directors: **Dr. Harold E. Edgerton,** board chairman and vice president of Edgerton, Germeshausen & Grier, Inc.; **Richard W. Jones,** managing partner of Mitchum, Jones & Templeton; **Robert J. Garon** and **Elmer R. Easton,** vice president and general manager, and vice president-field engineering and contracts, respectively, of Wyle Laboratories.

George W. Soderquist, president, Astronautics, Inc., Melbourne, Fla.

Jackson A. Wilcox, vice president and general manager, Beattie-Coleman, Inc., Anaheim, Calif., succeeding **Paul H. Hammond,** now executive vice president of the parent company, Coleman Engineering Co.

Frederick R. Lack, senior vice president-research, Sprague Electric Co., North Adams, Mass., and **Dr. Wilbur A. Lazier,** senior vice president-engineering.

Land-Air, Inc., a subsidiary of California Eastern Aviation, Inc., Washington, D. C., has elected the following managers as vice presidents: **Daniel R. Bannister,** Field Operations Division, Chicago, Ill.; **Robert M. Conway,** Point Mugu, Calif., Division; **Kenneth D. Cunningham,** Instrument and Electronics Division, San Leandro, Calif.; **Karl H. Keller,** Stepper Motor Division, Gardena, Calif.

George T. Scharffenberger, executive vice president, Litton Systems, Inc., a subsidiary of Litton Industries, Beverly Hills, Calif. Mr. Scharffenberger continues as president of Litton's Westrex Division.

D. Walter Swan, vice president and assistant to the president, Frontier Airlines.

Changes

Ezra Kotcher has been appointed to form and manage a San Francisco Bay area office for Aerospace Corp., El Segundo, Calif.

Raymond F. Jacque, manager-quality assurance, Military Products Division, General Dynamics/Electronics, Rochester, N. Y.

Robert J. Murphy, director of the newly created Military Requirements Department, Boeing Airplane Co., Seattle, Wash.

Dr. Robert S. Schairer, chief scientific adviser to the Commander, Pacific Missile Range, Point Mugu, Calif.

Donald W. Wohlgemuth, technical manager-pressure suit engineering, B. F. Goodrich Aviation Products, a division of the B. F. Goodrich Co., Akron, Ohio.

Howard J. Rowland, director of research and development, Antenna Systems, Inc., Hingham, Mass.

Brooks Honeycutt, Washington (D. C.) Representative-Navy, Allison Division of General Motors Corp.

INDUSTRY OBSERVER

► Navy interest in an anti-submarine seaplane has revived as a result of currently increased emphasis on anti-submarine warfare. Navy is working on development characteristics but hasn't decided whether the seaplane must be able to operate independently from unprotected water areas. Lack of this capability was one of the factors that led to cancellation of the Martin P6M. Any new aircraft would have to be able to operate with current aircraft tenders.

► **Over-all study of the bomber and air-to-surface missile combination is planned by USAF's Aeronautical Systems Division under SR 17543. Analysis will involve determination of the most effective bomber-missile combinations and feasible missions. New air-to-surface missile possibilities, including glide types, may be evaluated.**

► Hughes Aircraft Co. is developing long wavelength infrared detectors under Navy's Project Clinker which are capable of sensing heat differences in water trails of submarines.

► **Space Electronics Corp. will study an advanced radar-carrying earth satellite system under a $50,000 Aeronautical Systems Division contract. Differential doppler techniques will be investigated to obtain the high resolution required for such a system.**

► Vulnerability of Nike Zeus anti-ICBM missile guidance and control systems to countermeasures will be evaluated by an Army-industry team to determine what development changes may be necessary to attain maximum missile effectiveness.

► **Navy will request Fiscal 1962 funds to buy about 35 Grumman Gulfstreams as turbine-powered replacements for its Douglas R4Ds (DC-3s), used mainly by U. S. embassies and missions overseas. Choice has not yet been made between Rolls-Royce Dart and General Electric T64 turboprop engines.**

► Air Force Systems Command is planning development of electrostatic generators as possible weapons for use at altitudes approaching the limits of the atmosphere. Initial effort would involve both analysis and experimentation.

► **Hughes Aircraft Co. is studying the use of a 30-watt radioisotope electric generator in NASA Jet Propulsion Laboratory's Surveyor lunar soft-landing spacecraft, for which Hughes is prime contractor. In addition to its power function, the generator would supply heat to warm avionic equipment during the long lunar night.**

► Boeing is studying the feasibility of a compressed air Minuteman launch system, similar to the concept used with Polaris submarines. This would eliminate heat protection now required to protect silos and systems from the missile's rocket engine blast and could also make Minuteman adaptable for ship launching.

► **Proposals for a high-power, very low frequency transmitter—to be located in England and used to communicate with submarines—have been requested by the British General Post Office and are due July 1. Transmitter would be similar to but not as powerful as the 2-megawatt U. S. Navy unit at Cutler, Me., which is a communication link with Polaris subs. The British transmitter is to be financed by North Atlantic Treaty Organization and could be used with any Polaris submarines that might be integrated with NATO forces.**

► Several companies are financing their own Apollo spacecraft studies, with National Aeronautics and Space Administration's blessing. They hope that their proposals will be evaluated along with the results of NASA-funded studies being conducted by General Electric, Convair and Martin in the final Apollo program competition. One unfunded effort—at Grumman—reportedly involves over 60 people and over half a million dollars.

LIBRASCOPE COMPUTER FACILITIES

Shown below is a composite view of Librascope's facilities where a variety of computer systems are currently in different stages of design and production. Some are strategically involved with national defense...others deal with business and industrial process control. Each is uniquely designed to answer a particular need. The success of these systems illustrates the value of Librascope's engineering philosophy: A decentralized organization of specialized project teams responsible for assignments from concept to delivery...and backed up by excellent research, service, and production facilities. For your computer requirements, call on the company whose breadth of diversification in computer technology is unsurpassed. ■ Librascope Division, General Precision, Inc., 808 Western Avenue, Glendale, Calif. For career opportunities write to John Schmidt, Engineering Employment. ■

computers that pace man's expanding mind

Washington Roundup

Soviet Space Spur

Proponents of a bigger military space effort expect Soviet success in recovering a man from orbit to help them promote an expanded program. They have had relatively little success in the past, but—as usual—Russian success makes a U. S. space push suddenly more popular.

The military threat of Soviet space achievements was described the day before the man-in-space feat (see p. 32) by Air Force Chief of Staff Gen. Thomas D. White. He pointed out that the Russians are pruning obsolete forces from their military strength while they break new ground of their own in space. "I believe that a very critical period is upon us. In fact, I consider the total power represented by the growing Soviet aerospace strength to be perhaps the greatest threat in the history of our country," Gen. White said.

Soviet Union is providing a plush six-passenger Mi-4 helicopter as a gift to Cambodia. Following the usual pattern, a team of Russian technicians and pilots will go to Cambodia to assemble and test the aircraft.

Review of information for security has become almost a one-man affair in the Pentagon. Even relatively minor questions must now go to the office of Assistant Secretary of Defense for Public Affairs Arthur Sylvester for a ruling. Speeches are being confined largely to non-controversial material, with little or no reference to the Communist threat permitted.

Working level public affairs officials have a general guide, apparently drawn directly from a television interview of Defense Secretary Robert S. McNamara. He said military men shouldn't comment on foreign policy, and Sylvester has translated this into Public Affairs Guidance No. 18. This guidance is not officially available to the services for use in clearing speeches.

Russian Bilateral Snag

Scandinavian transit rights are the big stumbling block to Soviet operation of a Moscow-New York route. The Russians need landing rights or transit rights from one of the three Scandinavian countries, but Scandinavian Airlines System will offer stiff resistance.

Denial of SAS rights to cross Russia on flights to India is the reason. Soviets promised to give SAS a Moscow-New Delhi route as soon as navigational facilities were adequate. SAS has learned that the route is properly equipped and staffed with English-speaking personnel, but the Russians refuse to honor their promise.

Aeroflot once planned to fly north of Scandinavia on a great circle route to New York, refueling in Iceland. This plan apparently has been dropped as impractical, particularly in view of the Soviet desire to serve Havana on Aeroflot's transatlantic route.

Hawaiian, Alaskan and local service carriers will work hard to keep their total subsidy below $100 million a year, a level they consider the psychological limit in Congress. These airlines feel the $83.4 million requested for Fiscal 1962 will weather criticism because congressmen are reluctant to withdraw scheduled service from small towns in their districts to cut subsidy.

But the carriers think this reluctance will disappear if subsidy grows beyond the $100-million mark. They figure this would trigger a congressional investigation.

Continuing shift in power to civilian control over weapon system programs is again evident in Defense Department handling of the TFX fighter project. Office of Defense Research and Engineering, which is largely civilian staffed, has taken over USAF's planned tactical fighter and is running it as a tri-service effort (see p. 29). Control has extended as far as determination of development characteristics.

General Dynamics Upheaval Expected

Watch for a drastic reorganization pattern for General Dynamics, particularly its Convair Division, to emerge next week from a series of management and stockholder meetings. The board of management will meet Apr. 26 in New York, the annual stockholders' meeting is scheduled Apr. 27 in Dover, Del., then the directors will meet in New York the next day.

Management is planning reorganization moves to meet the demands of stockholders and directors who are unhappy over the unexpected $27-million loss last year. One sign of coming retrenchment was the sudden cancellation last week of all advertising in all media for the rest of the year.

Army light observation helicopter evaluation groups held their first meeting last week to integrate their findings and recommend a contractor to a selection board. LOH operational evaluation group from Ft. Rucker met with the technical group from Bureau of Naval Weapons.

Joint Chiefs of Staff development group has been formed to study the field of command and control. The group is headed by USAF Brig. Gen. L. G. McCollom.

—Washington Staff

Russians Forecast More Manned Flights

Soviets successfully recover first man from orbit; no immediate effect on Project Mercury expected.

By Evert Clark

Washington—Soviet Russia's success in making the first manned orbital flight will be followed quickly by similar Russian flights but will have no immediate effect on the U.S. man-in-space program, it appeared last week.

Soviet scientists said more manned flights will be made soon if extensive tests support the early conclusion that the world's first astronaut—27-year-old Soviet Air Force Maj. Yuri Alekseyevich Gagarin—was not harmed by his flight.

Alexander Topchiev, vice president of the USSR Academy of Sciences, said the successful flight means that the battle to put a Soviet astronaut on the moon "is half won," and said "it will be done."

The U.S. manned spaceflight program, Project Mercury, probably will proceed through its planned steps regardless of the Soviet success. President Kennedy and National Aeronautics and Space Administration officials indicated last week that there are no plans now to eliminate any flights or to accelerate the program in other ways.

U.S. Planning Influenced

The strong probability that Russia would try to put a man into orbit on or before its major national holiday on May 1 was taken into account in planning sessions before President Kennedy changed NASA's Fiscal 1962 budget requests late last month (AW Apr. 3, p. 30). This probability also influenced a recent decision to reschedule the first manned suborbital Mercury flight from early May to late April in the hope that the U.S. might make at least a ballistic flight into space before Russia made an orbital flight.

Russia said it successfully launched its 10,418.63-lb. spaceship—named Vostok, which means East—into orbit at 1:07 a.m. EST on Apr. 12 and recovered it at 2:55 a.m. after it had circled the earth once. Maj. Gagarin was in orbit for 89.1 min. and total time from launch to landing was 108 min., the Soviets said. The capsule's orbit had an inclination to the equator of 65.07 deg., a perigee of 108.76 mi. and an apogee of 187.66 mi.—a path that kept it below the Van Allen radiation belts.

Maj. Gagarin reported his reactions by radio during the flight and was monitored by telemetry and television. After he landed, he said he had been able to see "seas, mountains, large towns, rivers and forests."

"I felt at home," Gagarin said. "I feel well." The Soviet news agency, Tass, said that Soviet Premier Nikita Khrushchev telephoned from his vacation spot on the Black Sea to tell the major: ". . . By your feat you have made yourself immortal . . . Let the whole world see what our country is capable of, what our great people and our Soviet science can do."

Gagarin's Reply

Tass said Maj. Gagarin replied: "Now let all other countries catch up." The major has been a member of the Communist Party for the past year.

Reactions to the Soviet achievement ranged from wild celebrations in Moscow and congratulations from President Kennedy, Premier Khrushchev and many others to a "no comment" from former President Dwight Eisenhower.

The President called the flight "an outstanding technical achievement" and congratulated "the Soviet scientists and engineers who made this feat possible."

At a news conference on the day of the launching, he said "no one is more tired than I am" of seeing the U. S. second to Russia in the space field, but he said the advantage will be with Russia for some time because of Russia's lead in large rockets.

Soviet Union apparently tried at least one manned orbital flight in the few days before Maj. Gagarin's launching—probably on the day before. Rumors began to sweep Moscow on the week-end before the flight occurred on Wednesday. They gained strength on Monday when Soviet camera crews appeared in the central telegraph office ready to film and tape foreign correspondents' reactions to some great event.

Soviet officials did nothing to discourage newsmen's speculation that that event was an attempt to put a man into space. When nothing happened and the camera crew departed, newsmen—encouraged by some Soviet reporters—continued to expect something.

On Tuesday, the Communist London Daily Worker reported that a Soviet astronaut, the son of a prominent aircraft designer, had been orbited and recovered on Fri., Apr. 7, but that because of "emotional strain" he was not being shown to the public yet. Official announcement by Moscow Radio finally came on Wednesday morning, and the announcer said that the capsule then was still in flight.

U. S. Tracking Stations

U. S. officials deny that military and civilian tracking stations detected any flight on Friday. They did track an object on Wednesday, however, and NASA officials said there was no reason from what the U. S. knew to doubt that Russia did orbit and recover Maj. Gagarin that day as they said.

Unofficial U. S. sources, however, indicated that an object also was tracked on Tuesday. The Sohio Research Laboratory at Cleveland, Ohio, also recorded a signal on Tuesday that came from the southeastern sector of the Atlantic Ocean.

"This corresponds to the path a Soviet vehicle might take. Timing of Sohio's receipt of the signal indicated a capsule in that orbit would have made its landing about 6 p.m. Moscow time on the day before the announcement of Maj. Gagarin's flight was made.

Presidential Press Secretary Pierre Salinger said Vostok was "picked up by American tracking stations after it left the Asian land mass," and said "our tracking stations had it under observation during its flight."

Russia's claim to have had radio communication with its "cosmonaut" indicated that Soviet tracking ships were stationed in the Atlantic and Pacific Oceans. But the Defense Department refused to say whether the ships were

Space Slumber

Washington—When a reporter telephoned USAF Lt. Col. John Powers, press officer for the seven Project Mercury astronauts, early on the day of the launch to tell him Russia had placed a man in orbit and recovered him, the reply was this, the reporter said:

"It's 3 a.m. in the morning, you jerk. If you're wanting something from us, the answer is we are all asleep."

Rep. Thomas M. Pelly (R.-Wash.), reported this in a speech on the House floor. "I suggest that we went to sleep in 1945 and slumbered until the Eisenhower Administration got us under way in 1953," Rep. Pelly said. "By that time the Russians had established their tremendous lead in payload rocketry and today we have reaped the harvest of yesterday's neglects."

on station. In the past it has issued reports of their movements and released photographs of the ships taken from low-flying U. S. patrol aircraft. Some photos have even shown the aircraft's own wing tips.

Assistant Secretary of Defense for Public Affairs Arthur Sylvester said his department will not comment "on this sort of information" because "it deals with sources of information and methods of collecting information, part of which is highly classified." Russia has frequently protested the "buzzing" of these ships by U. S. aircraft, but the refusal to discuss their whereabouts appeared to be based on Sylvester's concept of security rather than concern over possible diplomatic complications.

Soviet scientists denied that there were any unsuccessful attempts at a manned spaceflight. Prof. Andrei Kuznetsov was quoted in the Communist newspaper Izvestia the day before Vostok was launched as saying that the USSR "stands on the threshold" of such a flight. Prof. Leonid I. Sedov, head of Russia's spaceflight commission and president of the International Astronautics Federation, was in the U. S. at the time of Vostok's launching. He said this was "the first try we made."

"This first cosmic flight of man will have the same meaning as the first airplane flight," Sedov told a news conference in Providence, R. I. In Moscow, government spokesmen had said the event was comparable in importance to the discovery of America by Columbus. Sedov said information on the flight will be published. He said Russia has published all its scientic information but there has been "some misunderstanding concerning this matter."

Soviet comments indicated that Vostok—unlike the Mercury capsule—may have used lift to aid in its landing. There has been some speculation that the six "spaceships" of the Vostok type flown since last May might be Russian equivalents of the U. S. Dyna-Soar boost glider, although Soviet references usually use the term capsule.

Prof. Vladimir Dobronravov said in Moscow that the spaceship must be braked and thermally insulated and that its downward course is mostly prolonged and flat. Prof. Anatoli Blagonravov, attending the second annual Committee on Space Research meeting in Florence, Italy, said after telephoning Moscow that he had no specific information, but that he assumed the spaceship was landed "by a combination of parachute and glider."

Blagonravov said the tests being made on Maj. Gagarin will determine how soon the next Russian astronaut flies. "You don't make these tests in 24 hr.," he said—but he indicated that the next flight would be immediate if the test findings were favorable.

MAJOR YURI A. GAGARIN

Dobronravov said the flight was proof that Russia's lead over the U. S. is immeasurable. He said Russia's capsules can be made "fully adapted to normal functioning of living organisms" chiefly because of their great weight, which in turn is made possible by the great thrust available in Soviet rockets.

Most Western observers have speculated until recently that the great weight of Soviet spaceships indicated they would carry two passengers. Late last month, however, Soviet scientists said the first man sent into space would be a Russian male, hinting he would have no "copilot" (AW Apr. 3, p. 35).

Nikolai Varvarov, identified as an astronautics specialist and professional pilot, said in Moscow that Maj. Gagarin was primarily an observer on his flight, which was controlled entirely from earth. But he also was an integral part of the project in that he controlled operation of devices that maintained required living conditions, Varvarov said. On later flights, he said, an astronaut will have a part in controlling the vehicle's flight.

Soviet broadcasts referred to Maj. Gagarin as a "pilot-space navigator." He is a carpenter's son, born Mar. 9, 1934 in the Smolensk district. He received "excellent marks" at a technical school, finishing in 1955, when he began studying in an aviation school at Orenburg. He has been an Air Force pilot since 1957. His wife is a graduate of a medical school at Orenburg, and he has two daughters, one two years old and one a month old, Tass said.

Following Radio Moscow's first broadcast concerning Vostok, which said the spacecraft was still in flight, radios and loudspeakers in Moscow's streets carried periodic announcements that the vehicle was over South America at 9:22 a.m. Moscow time, over Africa at 10:15 a.m. and slowing and re-entering at 10:25 a.m. About noon came the announcement that the landing had been successful.

Ordinary Soviet citizens were only mildly excited by the first news of the launching. Within a few hours, under the stimulus of radio and loudspeaker announcements and continuous playing of patriotic music, they were gathering in animated groups, especially around the Tass office, where a large photograph of Maj. Gagarin was displayed in the window.

This grew into calls for mass meetings in Soviet factories, excited celebrations in the streets and a rash of comments from coal miners, farmers and other Russian citizens on radio.

A tape recording of Maj. Gagarin's comments while in flight was played during official broadcasts. At 15 min. after launch, he reported: "The flight is proceeding normally. I feel well." At one point he said, "I am watching the earth. The visibility is good. I hear you well." Later he said: "The flight is proceeding well. I am watching the earth. The visibility is good. I can see everything. Some places are shrouded by clouds." Several times he reported that "the machine" was functioning normally. Capsule frequencies were 9.019, 20.006 and 143.625 megacycles.

Soviet newspaper Pravda indicated that Vostok landed in a farm field. One of the greeting party was the secretary of the Chkalov flying club. Chkalov—formerly known as Orenburg, which as Maj. Gagarin's home—lies near the border of Kazakhstan, about 375 mi. from the Caspian Sea. If the landing itself was made near Chkalov, the launching site probably was Tyura Tam, just east of the Aral Sea.

Aircraft, apparently assigned a search and rescue mission, flew near fields at which the capsule's flight was being monitored. Helicopters also were included in the rescue effort, and one was used to take Maj. Gagarin from his landing spot to the nearest town.

An Izvestia correspondent wrote that he had talked the previous day to a doctor "who was to parachute with a group of people from a plane at a point where Gagarin would land."

P. Isakov was quoted in the newspaper Trud as saying that the technical feasibility of "urgent lowering" of the capsule in case of an emergency had been worked out in Russia, along with procedures for normal landings.

Tractor drivers working the field where the major landed ran to congratulate him, Pravda said. He did not wait for them but walked to meet them. At the landing site and in later newspaper interviews, Maj. Gagarin gave these impressions of his flight:

"The sun in outer space is tens of times brighter than it is here on

earth. The stars are visible very well. They are bright and distinct." He said he did not see the moon.

"The day side of the earth was clearly visible," Maj. Gagarin said. "The coasts of continents, islands, big rivers, big surfaces of water and structural features were clearly distinguishable." As he flew over Russia, he said, he could "see distinctly the big squares of collective farm fields. It was possible to distinguish which was plowed land and which was meadows."

Maj. Gagarin said he had never flown above 50,000 ft. before so "I saw for the first time with my eyes the earth's spherical shape."

"You can see its curvature when looking to the horizon," he said. "I must say that the view of the horizon is quite unique and very beautiful. It is possible to see the remarkably colorful change from the light surface of the earth to the completely black sky in which one can see the stars.

"This dividing line is very thin, just like a belt of film surrounding the earth's sphere. This film or belt is like 'a narrow belt girdling the globe,' he said. It is of soft light blue color, and the entire transition from blue to black is most smooth and beautiful.

"It is even hard to put into words. When I emerged from the earth shadow, the horizon seemed different. It had a bright orange strip which then resolved itself into blue and again into pitch black."

The major said he does not think the time is far away "when we shall be able to carry out a flight to the moon, Mars and other areas of the vast outer space. This will take place, probably sooner than we think."

Neither weightlessness nor the transition back to gravitation were a problem, Maj. Gagarin said. He claimed that he hung in midair above his chair in the weightless state, "ate and drank and everything occurred just as it does here on earth." He said we worked in that condition, and his handwriting did not change as he made notes of the trip.

On re-entry, he eased himself back into the chair as his weight increased, he said.

Prof. Dobronravov said the Vostok capsule has the cosmonaut in a "stepped-lying position"—apparently the same position that the Mercury astronaut is to be in. He said the cosmonaut's torso "lies on the floor while his legs are placed in a chair to form a step."

Sen. Robert S. Kerr (D.-Okla.), chairman of the Senate space committee, called the flight "a fantastic, fabulous achievement," and said it "proves what the men in our space department have been telling us for a good while—that [the Russians] have been ahead in that phase of the space program." He said experts had reminded him, however, "that in the over-all space program we are ahead in many ways."

House Hearing

House Science and Astronautics Committee Chairman Overton Brooks (D.-La.) called NASA Administrator James E. Webb and Deputy Administrator Hugh L. Dryden to a hearing the day after Vostok's flight to hear their views.

They said essentially what they had at a press conference the day before, but Webb said that the budget increase requested by President Kennedy would not leave all the space spectaculars to the Russians.

Webb Says U.S. Pursues Own Pace

Washington—U. S. is pursuing "the solid, onward, step-by-step pace of our own program" in space and is more interested in that than "in being first," James E. Webb, administrator of the National Aeronautics and Space Administration said last week.

Webb said he was disappointed that Russia had put the first man into orbit around the earth. But he said: "I do not think that you can start out and say, 'we are going to be the first in everything the Russians may set out to do for themselves, or any other nation may set out to do for themselves.'

"We expect to be good and to be prompt and to be progressive with respect to the objectives we set for ourselves. But we certainly are not going to try to beat everything that any nation sets up as objectives . . ."

Dr. Hugh L. Dryden, deputy NASA administrator, said the Soviet flight in itself does nothing to affect the timetable of Project Mercury, first step in the U. S. man-in-space program.

"What the ultimate reaction will be, I am not able to forecast," Dryden said. ". . . Our programs are determined by the democratic process of this country in very many forums, including the executive branch of the government and the congressional branch." The Mercury timetable now calls for a suborbital flight early in May. Orbital flight is due "perhaps this calendar year," Webb said.

Project Apollo, the three-man orbiting laboratory and circumlunar vehicle that will follow Mercury, "already is an urgent program and in a time . . . when dollars are hard to come by," Webb said. "The President has added $125 million to his budget to provide the large rockets that will permit the going forward with this program."

NASA's Fiscal 1962 budget request asks $29.5 million to finance a study phase for Apollo. NASA has told Congress it is not satisfied with that, but President Kennedy did not request an increase in Apollo funds when he sent proposed changes to President Eisenhower's proposed budget to Capitol Hill (AW Apr. 3, p. 30).

Webb said parallel approaches to Apollo might be taken, as in atomic bomb development during World War II. "On the other hand," he said, "our present program is based on a solid, well-planned, step-by-step program, with each step undergoing evaluation and leading on to the next step, so that each step builds on the next, and this is a more economical and in many ways, I am told by my friends the scientists, a sounder concept for scientific development."

Soviets Claim Three Space Records

Washington—Soviet Russia has claimed three world astronautical records on the basis of Maj. Yuri Gagarin's flight in the spaceship Vostok. The official newspaper Izvestia said Sports Commissioner I. G. Borisenke met the major at his landing site and immediately claimed altitude, duration and load-lifting records for him. Preliminary claim has been filed with the Federation Aeronautique Internationale.

Last February, FAI members established five areas for manned space flight records—greatest altitude, with and without an earth orbit; and greatest mass lifted, with and without an earth orbit, and duration of orbital flight. Minimum altitude was set at 100 km, (62 mi.).

Russia still has not replied to the proposal that the four-man certification committee for these records be composed of the FAI director and representatives from three neutral nations. Russia recently has been waiting through most of the four months' reporting period and submitting documentation for its aeronautical record claims at the last minute.

Russia's telegram to FAI headquarters claiming the first manned orbital flight was signed by A. Koss, president of the Central Aero Club, and M. V. Kokkinaki, president of the sporting committee of the club, and president of FAI. Kokkinaki claims the world's 100-km. speed record (AW Mar. 27, p. 25).

Joint Fighter Concept May be Modified

By Larry Booda

Washington—Realities of economics and technology will force Defense Secretary Robert S. McNamara to modify his desire for a single tri-service tactical fighter, studies now in progress indicate.

Members of a Defense Department team recently completed a tour of seven airframe manufacturers and will soon visit an eighth. Their aim was to obtain information on state-of-the-art progress to determine whether a short takeoff and landing aircraft could be designed to perform ground support, reconnaissance, air superiority and interdiction missions.

This team was told that one aircraft could do the job, but it would be like "trying to combine a racing car's function with that of a heavy truck." The result would be "a monster" and would be prohibitively expensive. Airframe engineers generally said they would be glad to try, however.

Studies currently indicate that two aircraft could perform the four missions for all the services.

Shift to Joint Project

Air Force has been conducting design studies of a new STOL fighter-bomber during the past year and has sought funds to launch a development program. Kennedy Administration defense officials broadened this project to cover requirements for all three services (AW Mar. 6, p. 31). The President's Mar. 28 defense budget message included "development of an advanced tactical fighter," the tri-service project, for which $45 million was added to the budget request.

On Apr. 4, McNamara told Senate Armed Forces Committee that this is a joint project to replace the Air Force Republic F-105 and the Navy's McDonnell F4H. He specifically mentioned the variable geometry wing concept developed by the Langley Research Center of the National Aeronautics and Space Administration.

McNamara also specified an ability to operate from crude runways and with heavy conventional bomb loads. "In general," he said, "what we are striving for is one fighter to fill the needs of all the services."

At that time, details of what McNamara desired were not available to the services. The Army, Navy and Air Force all had numerous studies and development projects in progress in the V/STOL field.

Initial impetus for a joint project came in recommendations to McNamara from the special study panel on limited war and foreign commitments, headed by Paul H. Nitze, assistant secretary of defense for international security affairs. The defense secretary then directed Defense Director of Research and Engineering Herbert F. York to study integration of the separate service efforts, with a single-project goal in mind.

York then appointed a committee which at first tried to bind all requirements together around what until then had been the Air Force TFX, or tactical fighter project, under Specific Operational Requirement 183.

Numerous proposals had been received from airframe manufacturers. The Air Force intended to extract the best features from each for a design which would be prepared at Wright Air Development Division, which recently became the Aeronautical Systems Division of Air Force Systems Command.

After a final configuration had been established, a contract was to be awarded on the Air Force design. The contractor would build the composite aircraft. Companies involved object to such use of proprietary information, but they prefer not to protest officially to avoid jeopardizing their chances of getting the contract.

The three services were notified that the director of defense research and engineering would coordinate development characteristics based an the TFX design, which resembles a Republic Aviation proposal, and would assign management responsibility after a decision was reached.

Army and Navy officers are aware that the needs of their particular services were being compromised in such a proposal, but late last week they had not had any official opportunity to state their views. They have indirect representation in the Office of the Defense Director of Research and Engineering through officers on duty there, but the studies are being made principally by civilian officials.

As a result of the committee visits to Lockheed Aircraft Corp., North American Aviation, Douglas Aircraft Corp., Convair-Fort Worth Division, Chance Vought Corp., McDonnell Aircraft Corp. and Republic Aviation Corp., the switch to a two aircraft concept was initiated. Grumman Aircraft Corp. will be visited soon.

Committee members have flown several aircraft, such as the Convair F-106, Convair B-58, Chance Vought F8U, North American F-100, Douglas A4D and A3D, McDonnell F4H and the Republic F-105. The Grumman A2F remains to be evaluated.

Mission Considerations

In studying the mission areas, these considerations will have to be examined, assuming a 1965 first delivery date:

- **Air superiority.** This would require an aircraft that could operate at 80,000 ft., fly at speeds in the Mach 3 range and be capable of firing air-to-air missiles. It calls for a sophisticated intercept radar and fire control system. Landing speed would be in the 45-kt. range, with wheels large enough to operate on rough terrain and arresting gear for operation on aircraft carriers.
- **Interdiction.** In any weather, the aircraft would have to be capable of penetrating far behind battle lines—possibly up to 800 mi.—to cut lines of communication. Some observers maintain this would give it a strategic role. They say a more realistic figure is 300 to 400 mi. Conventional weapons, such as bombs and air-to-surface missiles, would be carried. To pinpoint small targets, another sophisticated radar would have to be carried, perhaps the map matching type. Operating conditions would be the same as for air superiority work.
- **Reconnaissance.** For battlefield reconnaissance, low-altitude capabilities are necessary, with side-looking radar and photographic configurations for oblique and vertical operations. Interdiction reconnaissance would be performed at higher altitudes, although 30,000 ft. is the practical limit. High speed for protection is mandatory. Electronic counter-measures equipment is also a requirement to spot enemy radar and communications locations. Operating conditions are the same as for interdiction and air superiority.
- **Ground support.** This calls for weapon capacity similar to that for

German Helicopter Needs

Bonn—Top officials of the West German Defense Ministry, air force, navy and army were scheduled to meet in Bonn late last week or early this week in an effort to standardize future needs in the heavy, medium and light helicopter fields.

Decision, which should lead to firm orders in the near future, has been postponed more than seven months and its latest target date, mid-March, has slipped quietly past. Any agreement at the Bonn meeting must still be approved by Defense Minister Franz Joseph Strauss.

U. S. helicopters under consideration in the evaluation include the Sikorsky S-61 and Vertol 107 in the heavy category and the lightweight Bell HU-1 (AW Feb. 27, p. 35).

interdiction, although it would be used close to the battle line. It is in this area that the Army and to some extent the Marine Corps feel that they have been neglected. They contend that smaller, cheaper and less complex aircraft are needed in greater numbers.

Marine Operation

The Marines currently are operating Douglas A4D single place, single-engine attack aircraft and McDonnell F4H twin-jet, two-place fighters from 3,000-ft. steel plank air strips. To support the Army, the Air Force Tactical Air Command is operating North American F-100s and Republic F-105s, both of which require longer, paved runways. The additional defense request includes $24.6 million to modify F-105s for smaller, rougher field operations.

A concept partially accepted by McNamara calls for basing most of the limited war forces in the continental U. S. He excepts aircraft carrier forces, which would be expected to fill an immediate role for tactical support in distant trouble areas.

This concept imposes a requirement of great ferry range, which in the case of the TFX is stated as 3,600 mi. Engineers maintained that reduction of this requirement would result in substantially lower costs.

Aircraft Cost

Another area which is being studied is the cost of a new aircraft, including construction of all its support installations and logistics when operating in the field, to determine whether a development program is economically feasible.

Commenting on the tri-service approach, Office of Defense Research and Engineering officials say they do not intend to enter into the management area but will insist on integrating diverse efforts aimed at common missions.

Practice Runs on Aircraft Halted After Sidewinder Destroys B-52

Washington—All practice runs on manned aircraft by Air Force fighters have been suspended in the wake of an accident in which a Strategic Air Command Boeing B-52 bomber was shot down by a Sidewinder missile fired from a New Mexico National Guard F-100.

After making five practice runs, the North American fighter released one of its two missiles carried on pylons under the wings. The missile entered the exhaust section of an engine under the B-52's left wing, causing it to explode and buckle the wing.

The bomber crashed in rugged mountain territory northwest of Albuquerque, N. M., killing three of the eight crew members. The other five parachuted and were rescued.

The F-100 was one of two aircraft being flown on an Air Defense Command alert flight. It has been standard practice to make non-firing runs on B-52s. Pending the outcome of the USAF investigation of the incident, these runs have been discontinued on all manned aircraft.

Since it was on an alert mission, the F-100 was carrying at least one active Sidewinder, although some of these interceptors fly with two. When only one is carried, the other wing carries a dummy missile to maintain aerodynamic balance.

The missile which was fired might have had an active infrared sensor and a dummy warhead, but even this combination would cause a jet engine to explode.

As part of the fail-safe system in the F-100, a circuit breaker and three switches must be closed before the missile can be launched. There also is a pin in the trigger on the control stick which must be pulled out before the trigger can be pulled.

In this case, the fighter was making camera firing passes and therefore probably had the pin pulled and the gunsight and camera switches on. Even so, there still would remain a circuit breaker and two switches open to block firing.

As a complicating factor, there are two trigger switch positions. Pulling it to the first indent causes the camera to operate. By pulling harder past a higher spring resistance, the guns or missiles are fired, but only if the circuit breaker and two switches are closed.

Standard operating procedures dictate that all armament switches must be off at all times. Also, a pin must be removed from the launcher rails before the missile can be fired. This is done normally at the end of the runway before takeoff by a ground crewman. During this operation, the pilot hangs both arms outside the cockpit to assure the ground crewman that he is not touching the switches.

In making a ground controlled intercept (GCI), the GCI operator makes the pilot go through a checkoff list which requires that all armament switches be off, which the pilot acknowledges.

In any actual firing of a Sidewinder in practice, the fighter must be in range, it must not be pulling more than 1.5g and the pilot must hear a tone in the headset.

The tone gets louder the closer the fighter gets to the target. This indicates that the infrared sensor is receiving a signal and that the guidance circuitry is functioning correctly. The tone is audible in the 180 deg. semicircle to the rear of the target.

Most practice firings have been made against flares held aloft by balloons, or against an HVAR rocket.

Several experimental firings of MB-1 Genie air-to-air rockets have been made against other aircraft, with the target aircraft breaking off the run before intercept.

All-Weather Sidewinder

Washington—New all-weather Sidewinder is becoming operational with the Air Force and the Navy. In addition to an infrared sensor, it carries semi-active radar to home on a target illuminated by the firing aircraft. Radar will guide the missile through clouds until the infrared signal received is strong enough for the sensor to take over guidance.

Range of the new missile is from three to 10 mi. It will operate up to 85,000 ft. and travels at a speed of Mach 3.

Polaris A3 Will Use New Double-Base Fuel

Washington—Increased range of the 2,300-mi. Polaris A3 fleet ballistic missile will be achieved by switching to a new, nitro-plasticized, double-base solid propellant which is denser than the composite polyurethane fuel used in the first stages of the shorter-range A1 and A2 models.

Elasticity of the new fuel, made by Aerojet-General, Polaris first stage engine contractor, permits a reduction in the amount of binder material required to hold solid propellants together. With this denser propellant, the A3 will have 800 mi. greater range than A2. First stage engines of both A2 and A3 are 30 in. longer than the first stage case of the 1,200-mi. A1, allowing them more propellant.

To obtain the double-base propellant, Aerojet mixes a nitroglycerin-like nitro compound, with aluminum powder additives, in a nitrocellulose binder. Oxidizer is ammonium perchlorate, with additional oxygen atoms drawn from the nitro compound. The nitro-plasticized fuel burns about 1,000F hotter than the polyurethane propellant and, because of the higher oxygen content, provides a small increase in specific impulse.

Cost of the new fuel is expected to be 30-40% higher than the present composite propellant.

Industry Fights New USAF Test Policies

Washington—Aircraft manufacturers are raising strong objections to what they believe are Air Force moves to completely take over development flight testing of new manned aerospace vehicles and to give military pilots a substantially increased role in production flight testing.

The furor was touched off when Boeing Airplane Co. was notified that the Air Force would take over flight testing of the Dyna-Soar boost glide orbital vehicle and was intensified with indications that a similar move would be made in the North American B-70 program.

Historically, contractors have been charged with fulfilling most of the test mission during development and production, with the Air Force making flights to check the manufacturer's performance.

Highlighting the controversy is the shrinking activity in the airframe industry, compared with World War II and the Korean War.

Civilian test pilot employment is now down to about 325.

Air Force reports that it has 6,000 excess pilots, and its projected aircraft inventory will decline further with the shift to missiles for the deterrent role. A factor in addition to the economics of employment, is the prestige which accrues to the pilot and the company or service making first flights and record flights.

Cost is Reason

Cost is the reason given by the Air Force for moving into the development flight area. In production flight testing, USAF says that uneconomical practices have resulted in great increases in flight time on an airframe before it is delivered.

In the case of one single-engine aircraft fighter now in production, the Air Force found that production flight tests had increased to an average of 15.7 flights per aircraft before delivery. With flight costs running $2,000 to $3,000 per hour, testing costs were running high. And USAF says its crew chiefs were complaining that aircraft were being delivered needing the first periodic flight check.

No definitive policy action is presently being taken in the development testing area, but a proposed new directive covering aircraft acceptance flights is being written. It would cover rules for first production flights demonstrating basic airworthiness and functional systems operation, statistical flights and reflights.

The standard production contract requires the manufacturer to deliver a complete system. Before the Air Force accepts the airplane, its operation must be demonstrated. Past practices have required that the aircraft be flown until every defect has been cleared. In the case of all-weather aircraft with complex navigation and bomb delivery systems, problems appear on every flight.

More Ground Work Needed

In the case of the single-engine production aircraft mentioned above, the Air Force determined that more thorough ground review and testing was the answer.

Before first flight, a complete integrated systems analysis is performed on the ground. Then all reported equipment malfunctions are analyzed on the ground, rather than in the air.

Next, a review of specifications control is made to see whether required standards are met and finally government furnished equipment is analyzed to see if it meets specifications.

Air Force says it is not trying to do the contractor's work, and it is not trying to recalibrate aircraft. It is trying to use empirical data to show the Air Force and contractor better management techniques.

Aerospace Industries Assn., representing airframe manufacturers, and the Society of Experimental Test Pilots object to any encroachment into the area of work done by contractor-employed test pilots. Both organizations primarily stress the importance of continuity in flight-testing.

Each pilot, they say, "lives" with a project from its inception, and, as an engineer, participates in every decision regarding configuration, aerodynamic characteristics and equipment over a period of years.

The pilot then conducts the flight tests as a climax to the project, they argue.

As an employe of the manufacturer, he is subject to its discipline and is part of the engineering team.

Industry Argument

An argument cited against the employment of military pilots in contractor testing is that military pilots, even if qualified engineers, rarely can stay with a project from its beginning to delivery.

An area of mistrust regarding military pilots is the crossflow of proprietary information. Manufacturers claim their own pilots will not reveal such information. On the other hand, the Air Force says that much progress is stifled by having "tricks of the trade" held too closely, to the detriment of the weapons manufacturing effort.

An Air Force Inspector General team which made a recent survey of flight test activities by contractors said that the Air Force could do it cheaper. AIA claims, however, that this is doubtful because the service does not calculate the cost of the overhead of such large installations as Edwards AFB, Calif., Eglin AFB, Fla., and Wright-Patterson AFB, Ohio.

Flight safety also has been under discussion, but no figures have been presented to show any significant difference between contractor and military test pilots.

Explaining the Dyna-Soar decision, the Air Force said that it represented a special situation. It was pointed out that the vehicle will fly both in space and the atmosphere.

In Project Mercury, which is being conducted by the National Aeronautics and Space Administration, the pilots are military men, Air Force points out.

Since such a combination vehicle as Dyna-Soar using both rocket boost and space and aerodynamic flight, has no precedent, USAF decided to follow the lead of the Mercury program.

A quite different example was the case of the B-47 modifications under Operation Milk Bottle. Testing of the modifications and fixes to strengthen wings on that aircraft at Douglas-Tulsa and Lockheed-Marietta, was done by Air Force crews, with no company test pilots used.

Sore Point

A sore point with both company pilots and Air Force pilots stationed in Air Force plant representative's offices, is that it is difficult to abide by Air Force regulations regarding flight proficiency because they make fewer and shorter flights.

Night landings and instrument flights in type are required, and once lost, the qualification in type is almost impossible to regain.

In many instances, combination crews have conducted tests. Company pilots feel, however, that no matter how friendly they may be with military pilots, they cannot gain needed professional rapport with them in the cockpit because of the differences in knowledge of a project.

The X-15 program has been cited as an example of Air Force-NASA-industry cooperation in a developmental flight test program. The basic company pilot briefed the other pilots continually. He was working full time on the project while the government pilots were involved in other programs. Nevertheless, the program has had success so far, the Air Force maintains.

USAF Opens Congressional Drive For B-70 Weapon System Effort

By Katherine Johnsen

Washington—Air Force opened a drive in Congress last week for reinstatement of its B-70 bomber as a full weapon system program, with USAF Secretary Eugene M. Zuckert warning that the reliability of missiles has not yet been proved.

The Eisenhower Administration's final B-70 program for complete weapon system development of 12 aircraft was cut back by the Kennedy Administration to development of four test aircraft.

"For the time being we should view missiles with some caution . . . we must guard against overdependence, or overconfidence," Zuckert told the Senate Armed Services Committee.

Zuckert observed that the manned bomber's operational advantages of prompt response and absolute control are directly related to the national policy to achieve an effective international arms control plan, particularly in the nuclear field.

"Strategic missiles carry nuclear warheads only," he commented. The stretch-out of the B-70 program, Zuckert stressed, will result in a greater ultimate expenditure, as well as deferral of its operational use.

Air Force Chief of Staff Gen. Thomas D. White, re-inforced Zuckert's presentation. "We cannot afford to base our force structure on the premise that any one particular strategy will be followed," Gen. White told the committee. "I am deeply concerned with the need to maintain a proper mix of manned and unmanned weapon systems." Although intercontinental ballistic missiles are "exceptional" weapons, he observed that "they cannot perform all essential combat tasks."

After the closed-door session, Sen. Richard Russell (D.-Ga.), chairman of the armed services group, reported that "many" committee members have "very serious doubts" as to the advisability of reducing Fiscal 1962 funds for the B-70 from the $358 million recommended by the Eisenhower Administration to $220 million.

Meanwhile, R. A. Lambeth, senior vice president of North American Aviation, said that over-all, the company will not be adversely affected by the Kennedy defense plan: The reduction in the B-70 program will be counterbalanced by increases in the Minuteman and Polaris programs. North American produces the guidance systems and ground control equipment for Minuteman, and auto-navigators used in Polaris submarines. Lambeth pointed out that the B-70 is "but one large program in the total spectrum of company business. One of the benefits, indeed, one of the purposes of our diversification policy has been to make the company's sales pattern relatively invulnerable to sudden contract changes."

Gen. White gave this timetable for the phase-in of ICBMs:

- **Atlas.** The entire program of 13 Atlas Squadrons—123 operational launchers plus 9 training launchers—will be completed by the end of 1962.
- **Titan.** The entire program for 12 squadrons—108 operational launchers and 6 training launchers—will be completed by the end of 1963. Titan will have an "emergency" combat capability later this year.
- **Minuteman.** There will be an "emergency" combat capability with a "limited" number of these missiles in 1962.

Gen. White and Adm. Arleigh Burke, chief of naval operations, emphasized fast-developing Soviet military strength in their testimony.

"The Soviets no longer walk in our footsteps . . . they are breaking new ground on their own," Gen. White observed. He anticipated that the Soviets could and might launch a large space platform—"truly a major rung in the ladder to the achievement of effective space weapon systems."

Intensive research and development programs under way in the USSR, coupled with the pruning away of "large masses" of obsolete and obsolescent forces from the existing Soviet military strength, Gen. White declared, are evidence that "a very critical period is upon us." He stated that Russia is probably the only country—aside from the U. S.—that can afford to support sustained exploration of all fields of science pertinent to military power.

Adm. Burke reported that a Soviet version of the Polaris submarine is expected "in the near future." He said that it is "probable" the Soviets already have some nuclear submarines, but "problematical" whether they are yet fully operational.

The Communist Chinese navy—the largest wholly Asian naval force in the Far East—includes a "significant submarine force and a well developed naval air arm," Adm. Burke said.

Meanwhile, in a Washington speech to 4,000 naval officers, Navy's new secretary, John B. Connally, expressed his support for the Navy's losing fight over the past several years for funds to modernize its obsolescing aircraft fleet. Navy is approximately 250 planes short of its requirement for 7,200 operating aircraft. Procurement over the last four years has averaged 662 per year, compared with annual losses from accident and wear-out averaging more than 800.

On the other hand, Connally called on the officers to be "ruthless" in eliminating projects of dubious value. "We cannot use our active shipbuilding and aircraft purchase programs to carry long-range research and development programs. We must consider the cost of sophistication and its impact on reliability and the numbers of individual ships and aircraft we are able to buy."

Connally also announced a crackdown on anonymous statements by officers over-zealous in promoting Navy interests. He told the officers:

"Recognize and accept your own responsibility by insisting upon being quoted by name, rank, and billet . . . in short, if you are not willing to be quoted by name, you should not be speaking."

In another development, a detailed breakdown by Secretary of Defense Robert S. McNamara to the House Armed Services Committee disclosed that the Kennedy Administration program calls for these additional funds for Fiscal 1962: Defender, $21 million; Advent, $15 million; Discoverer, $30 million; and Saint, $14 million.

Supersonic Transport

American Airlines' President C. R. Smith related the future of supersonic jet transportation to additional B-70 expenditures and research. He cited 15 years as a realistic period for the inauguration of civilian supersonic travel.

Smith, in accepting the Maj. Gen. William E. Mitchell Award from American Legion Aviators' Post No. 743, said that the B-70 is no panacea to the problems at large but nonetheless "should precede the supersonic transport."

F-1 Chamber Firing

Edwards Rocket Base, Calif.—Full-size tubular-walled thrust chamber of a Rocketdyne F-1 liquid-propellant engine developed 1.64 million lb. thrust here in a 13-sec. test firing.

The thrust chamber test was in preparation for tests later this year of the complete F-1 propulsion system. Turbopumps and other components are also being tested independently.

Propellant tanks were pressurized to maintain the propellant flow during the thrust chamber test because no suitable pumps were available. A 1.55-million-lb. thrust was achieved in February with a smaller uncooled chamber as part of the F-1 program.

Defense to Obligate $8.5 Billion by July 1

Washington—Kennedy Administration hopes to obligate $8.5 billion in defense procurement, research and development and construction money in the last quarter of Fiscal 1961, compared with $5 billion for each of the three previous quarters of this fiscal year. This would bring the total outlay in these three categories for Fiscal 1961 to $23.7 billion—the highest level since Fiscal 1952, which reflected rearmament for the Korean War.

Charles J. Hitch, assistant secretary of defense-comptroller, told the Joint Congressional Economic Committee last week that the intended $8.5-billion outlay in what he called the three "investment" categories of procurement, research and construction is a "target . . . within the realm of the attainable. The stimulating effect of such an increase in industry's new orders should be highly significant for the recovery." The Fiscal 1960 outlay in the three investment categories totaled $19 billion.

Under questioning, Hitch modified two basic Administration positions—that neither budget ceilings nor the state of the economy are major factors in determining the level of defense.

Hitch conceded that cost is "an important consideration" in determining the defense budget in response to the observation of Sen. William Proxmire (D.-Wis.) that the Kennedy Administration is approximating the Eisenhower Administration in its defense program, rather than following the recommendations of the Rockefeller or Gaither committees that a major augmentation of the nation's military power is necessary.

Hitch also said that—if necessary because of a slack economy—the Administration might continue its acceleration of defense programs beyond the April-June period of this year for another "year or two years from now." This would not necessarily entail an increase in the over-all defense effort. It would mean the letting of contracts at a faster rate and the making of payments for production at a faster rate—the same policy being followed for the last quarter of this year.

This statement followed the observation of Sen. Proxmire that the Kennedy Administration is accelerating defense contract awarding and expenditures for the April-June period "at the expense of the future"—of slowing down production in later months. It was made in the context of previous testimony by Walter Heller, chairman of the President's Council of Economic Advisers, that the current recession could extend beyond the expected period of a few months.

Hitch emphasized that the Kennedy Administration's revisions in the defense program—resulting in a net $1.95 billion increase in cost—touched only highlights and a request for additional Fiscal 1962 defense funds is "possible."

Barring continuation of the recession, Hitch emphasized that the $8.5 billion per quarter rate "cannot be continued during fiscal year 1962. Allowing for the usual seasonal pattern, we estimate that perhaps $9-10 billion will be obligated in the first half of the fiscal year (July-December, 1961) and $12-$13 billion in the second half (January-June 1962)."

Malfunction Caused Discoverer Failure

Los Angeles—Stability malfunctions with Discoverer XXIII's Agena B vehicle caused both the vehicle and the separated capsule to remain in orbit, eliminating the possibility of retrieving the data package within the capsule.

Probability is that Agena B was not tipped down according to programing schedule, just prior to capsule separation, so that when separation occurred, retrorockets continued to push the capsule in its orbital path instead of directing the capsule downward into the earth's atmosphere for programed letdown by chute deployment from about 50,000 ft. (An ablative shield drops off after the parachute is deployed.)

Data were received from the satellite for approximately two days prior to the separation attempt. Agena B was specially instrumented to determine methods to improve the stabilization technique. Other instrumentation was involved in a test of guidance components and investigation of propulsion factors. This was the second Agena B firing in which the Bell Laboratories closed loop guidance system was used, the same system as used in Titan I.

DH-125s Scheduled For 1963 Delivery

London—Plans to proceed immediately with production of the DH-125 jet executive aircraft were revealed by Hawker-Siddeley Group.

An initial production batch of 30 DH-125s (AW Feb. 27, p. 34) is being prepared for delivery beginning in 1963. Total investment will exceed $10 million.

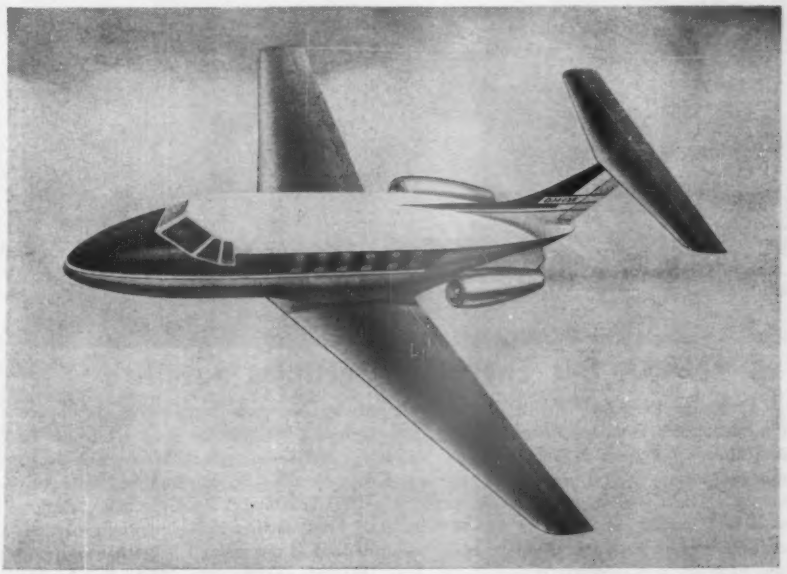
The design, which de Havilland says may remain current for 20 years, will seat eight passengers in a cabin pressurized for cruise between 450 and 500 mph. over a range of 1,500 mi. It will be powered by twin rear-mounted Bristol Siddeley Viper turbojets.

The company says the aircraft will be easy to fly, will operate from small fields and have relatively simple systems.

The Viper 20 turbojet will be the latest development of the Viper series, uprated by adding a "zero" stage to the front of the compressor and increasing turbine capacity.

Mass flow of the engine is increased from 44 lb. to 51.8 lb. and thrust from 2,500 lb. to 3,000 lb.

Temperature has been dropped 25% to improve the life of the hot parts. Fuel consumption of the engine will be 0.985 lb./lb. thrust/hr.



HAWKER-SIDDELEY GROUP DH-125 executive jet aircraft will be powered by a 2,500-3,000 lb. thrust Viper 20 turbojet. Plane will seat eight passengers, will cruise between 450-500 mph. over a range of 1,500 mi.

Umbaugh, Fairchild to Begin Arbitration

By John Nammack

New York—Umbaugh Aircraft Corp. is approaching a critical stage in the marketing of its autogiro, the U-18, as the issue of its contract for assembly of the aircraft with Fairchild Engine and Airplane Corp. goes into arbitration before the American Arbitration Assn. here this week.

Fundamental to the issue is Umbaugh's stated determination to hold the selling price at just under $10,000, based on a first-year production run of 10,000 aircraft. Fairchild says it is willing to build the plane. However, the question of how much the current U-18 differs from the one on which Fairchild quoted prices in an assembly contract two years ago, is now an issue as Fairchild seeks price increases.

Terms of the contract dated Aug. 7, 1959, called for delivery of 98 production aircraft prior to May 1, 1960, another 400 aircraft by July 1, 1960, another 500 by Aug. 1, 1960. Production was then to rise to 1,000 a month until completion of the batch of 10,000 by May 1, 1961.

Unit prices were to begin at $7,146 for the initial production batch of 98. The next batch would carry a unit price of $4,258 and the price would continue to drop until it reached $2,468 for the last batch of 5,000. Total price for the 10,000 run was estimated at $12,340,000, including tooling, but the original terms covering prototypes and tooling were later revised to some degree.

Umbaugh was to supply blades, engines, propellers, battery, landing gear and instruments.

The contract permits Umbaugh to change the delivery schedule on written notice, but not without consent of Fairchild if the change means a substantial increase in Fairchild's plant, equipment or number of employes. There are also provisions for termination, which undoubtedly will be at issue in arbitration.

Coincident with the contract dispute, Umbaugh announced that contracts for U-18 components had been signed. Lycoming Division of Avco Corp. will supply 180-hp. O360 engines, though the initial quanity to be delivered is small; Parsons, Inc., will produce 30,000 rotor blades, with the initial delivery order reportedly calling for 10,000, and Aviation Products Division of Goodyear Aircraft Corp. will furnish tires, wheels and brakes.

Latest in a series of target dates calls for production and Federal Aviation Agency certification flight tests to begin early in May, with full certification expected by July 1. The FAA still is reviewing U-18 technical data; an agency spokesman told AVIATION WEEK that although he could not reveal a specific date, the FAA was close to initiation of its flight-test program.

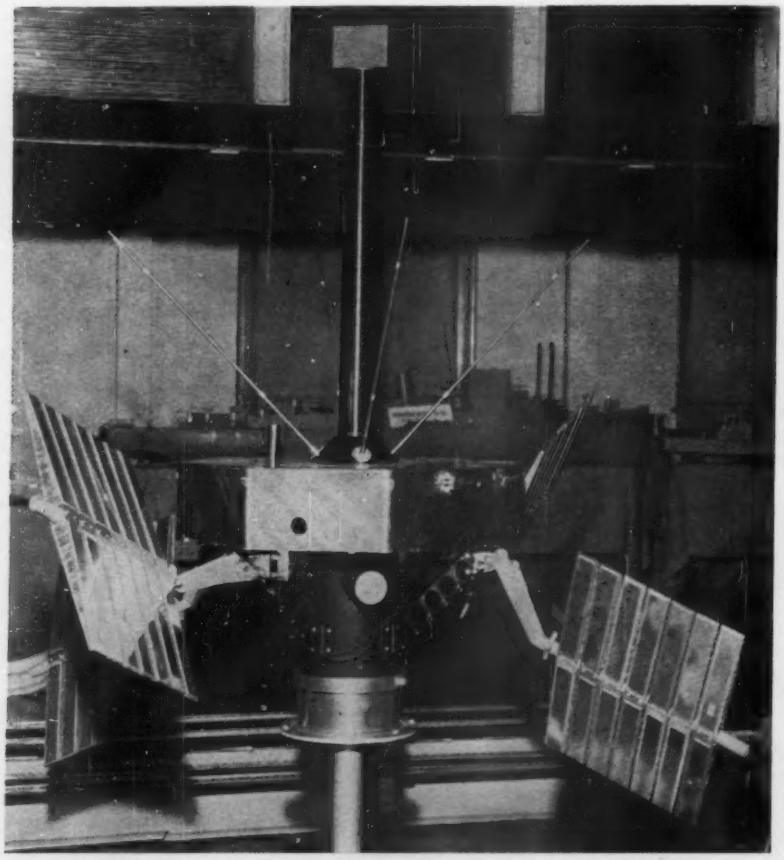
Initial deliveries of the Lycoming engines and Parsons rotor blades are scheduled for May, and Umbaugh says it will go ahead with production of the U-18 next month regardless of the status of the certification program (AW May 9, p. 33)

Sales Program

Umbaugh has taken close to $15 million in dealer and distributor deposits on what a company spokesman says represents over 9,400 orders for the U-18. According to Umbaugh, this total includes 1,400 orders from Latin America, with 400-aircraft orders taken from Trabajos Aereos Lopez y Uriarte of Argentina and from a company in Brazil.

Umbaugh spokesmen say there have been a few requests for refunds from depositors because of delay in the program, one from a dealer in the South. The usual U-18 aircraft deposit is $1,500; dealership is $20,000 and distributorship $80,000.

Umbaugh faces a basic problem in the development, manufacture and marketing of the U-18 in that deposits accepted for the aircraft are, in fact, liabilities requiring delivery of completed, certificated airplanes eventually. Thus any price rise in manufacture or added development and certification costs exert a powerful squeeze on prof-



NASA S-3 Energetic Particles Satellite

S-3 Energetic Particles Satellite being developed by National Aeronautics and Space Administration's Goddard Space Flight Center is tested for the magnetic influences of its electronic system in Naval Ordnance Laboratory's magnetic research area, which NOL calls the world's largest controlled magnetic field. Satellite, to be launched later this year by a Delta vehicle, will measure earth's magnetic field and Van Allen belt radiation in an orbit varying from 150 to 40,000 naut. mi. NOL facility is built entirely of non-magnetic materials. Large electrical coils (top, rear) cancel out natural terrestrial magnetic field to create a completely non-magnetic area. Satellite will be returned to this facility before launching for calibration of its magnetometer, which extends three feet from the main body. S-3 uses four folding paddles to collect solar energy for powering instruments.

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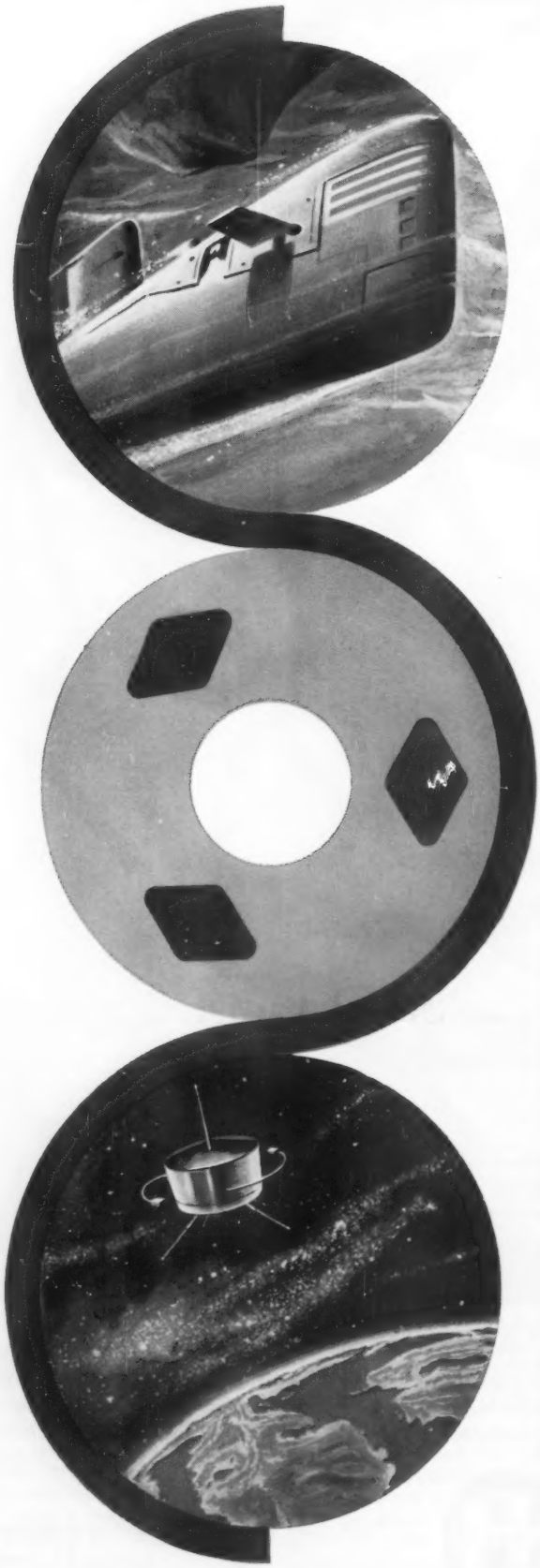

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R-131

itability of the Umbaugh 18 program.

Historically the problem of a jump takeoff autogiro has been that it requires a rotor head and gearing with the integrity of that of a helicopter, thus militating against low cost. Some flight problems also have existed: a drop in altitude on jump takeoff as rotor acceleration drops like that of an airplane leaving a carrier deck, and the fact that a pilot usually is committed once he begins a landing in a relatively confined area since the autogiro must be flown out like an airplane to make a go-around.

Umbaugh says that it will provide all dealers and their salesmen with instruction in the U-18 at Hagerstown, and will provide dealers with a standard sales contract. Post-delivery maintenance will be the responsibility of the individual dealers, many of whom are not experienced in aviation.

Deposits are now being used in financing of the program, an Umbaugh spokesman said. But he claimed that until recently, Raymond E. Umbaugh, president of the company, had financed the entire cost himself, a total of about $3½ million.

Little is known of Umbaugh's financial affairs since he has never sought public financing for any of his enterprises nor used the usual credit sources.

The Umbaugh 18 is a two-place autogiro, with a top speed of about 126 mph. It cruises at 100 mph. at a 65% power setting, over a 350-mi. range without refueling. Designed for low-level operation, it reportedly can climb at more than 1,000 fpm. and has a service ceiling of 15,000 ft. Umbaugh plans to sell the U-18 for $9,995, and claims that operation and maintenance costs are approximately six cents per mile.

Load Factors

The aircraft, designed for a mass market of amateur flyers, has conservative load factors. A limit landing load factor of 3 and a flight load factor of 2.25 were chosen. In general, the aircraft was designed to U.S. Civil Air Regulations Part 6, and where this was not applicable reference was made to Part 3, as in the engine-propeller combination and the tail surfaces. Crash load factors specified in Part 6 were included in the design to eliminate the danger of the pylon, engine or center section collapsing on the cabin in minor crashes. Sections of the forward fuselage also were included in the crash requirement, resulting in a somewhat heavier, more rugged structure than might have been achieved by designing for minimum weight.

The U-18 has passed through a succession of tail modifications, normally symptomatic of directional control problems. Final triple tail configuration removes the maximum amount of tail area from the propeller slipstream for stability while leaving the all-movable center tail section incorporating the rudder in the slipstream for maximum rudder effectiveness. The tail was trimmed at top and bottom to reduce its over-all size.

The U-18 has jump-takeoff capability and can be flown as a conventional fixed wing aircraft. In the latter case, it requires a distance of about 50 ft. from starting point to clear a 50-ft. obstacle.

Gilbert DeVore, chief engineer for Umbaugh and former rotary wing flight test engineer for the Civil Aeronautics Administration, said that the question of excessive rotor torque during jump takeoff of the U-18 is resolved by using only rotor inertia for the jump, and by disengaging the driving gears before the plane is jumped.

The only torque acting on the aircraft comes from the propeller, and it is compensated for by an initial deflection of the control stick, gradually reduced to trim position as the gyro accelerates to level flight.

An ejector system was adopted for engine cooling, and although less efficient than ideal types because of its elbow bend, it is said to perform adequately and to maintain engine temperatures in the proper range. Oil cooling system is separate from the engine, with its own inlet and flapped exit. The system works well for all flight conditions except long duration flights at low speed, when oil temperature becomes excessive, an Umbaugh spokesman said.

One of the five U-18s already assembled at Fairchild's Hagerstown, Md., facility has been instrumented for vibration surveys. The aircraft has been shaken on the ground through a range of 2 to 100 cycles per second, and was checked for all modes and shapes of natural frequencies. This range of speeds covers all rotor, propeller and engine rpm. settings.

Of the other three U-18s now on flight status—the fifth was damaged in an accident last March reportedly caused by failure in a landing gear tie-rod fitting which eliminated the gear's damping properties, resulting in reinforced vibrations—one aircraft is engaged in endurance testing of the rotor drive, a second is being used for company flight tests, and the third is being readied for the FAA flight-test program.

Early Flight Testing

Ship with serial N102U, used in much of the early flight testing, shows some patching in the fairings of the tail boom beneath the cowl. This resulted from vibration of engine and cowl and was corrected by providing a larger angle and rubber bulb at the intersection of the cowl and fairing.

In the event Umbaugh's contract with Fairchild is terminated, an Umbaugh spokesman said that production would be shifted to one of several alternate assembly sites. Under consideration are the Jonco plant in Pawnee, Okla., another in Oklahoma City, and a third in Wichita, Kan.

Umbaugh has a four-place version of the U-18 in the design stage, and is considering additional power for the aircraft either by turbo-supercharging, increasing the horsepower of the basic engine, or adding a shroud to the propeller to increase available thrust.

USAF Blue Scout Capsule Is Lost

Washington—Four-stage Air Force Blue Scout II vehicle launched a 360-lb. scientific payload to a peak altitude of 1,200 mi. last week, but its 90-lb. recoverable capsule was lost after landing 1,650 mi. down the Atlantic Missile Range.

High seas forced recovery forces to abandon attempts to locate the capsule in the impact area, some 300 mi. northeast of Antigua Island, about 10 hr. after its launching Apr. 12, the first by an all-Air Force crew. Failure to recover the nuclear emulsion package meant the loss of two experiments; data from the other five instruments in the payload was telemetered back to ground stations.

The experiments, six of them sponsored by USAF's Geophysics Directorate of Cambridge Research Laboratory, and one by the Aeronautical Systems Division, included measurements of:

- **Micrometeoroid** concentration, size and flux.
- **Density of back-scattered,** or albedo, neutrons.
- **Concentration and energy** distribution of charged particles in the upper atmosphere as a function of time and position.
- **Electron density** in the upper atmosphere, for communication systems research.
- **Feasibility** of making accurate geodetic measurements to improve correlation of international land mass position data.

The two experiments contained in the lost nuclear emulsion package were:

- **Accumulated effect** of particle radiation, at various energy levels, on film—the experiment prepared by Aeronautical Systems Division.
- **Traces of cosmic rays,** as recorded on an emulsion plate.

House Group Acts On Space Council Change

Washington—Legislation shifting responsibility for planning all military and civilian space programs from the President to the National Aeronautics and Space Council, headed by the Vice President, was approved last week by the House Committee on Science and Astronautics.

Senate space committee is expected to act on the bill either this week or next, and chances of prompt House and Senate approval appear favorable.

The bill would replace the President with the Vice President as chairman of the space council. It also changes Space Act language to make it clear that the council is to oversee and coordinate the space efforts of all U. S. agencies.

The bill reduces membership on the council to five: The secretaries of Defense and State, National Aeronautics and Space Administration administrator and Atomic Energy Commission chairman in addition to the Vice President. The present law provides for the appointment of one other member from a government agency and three additional non-government members.

Although it will be the duty of the council generally to "advise and assist the President as he may request," the bill lists these specific functions:

- **"Survey all significant** aeronautical and space activities, including the policies, plans, programs, and accomplishments of all departments and agencies of the United States engaged in such activities.
- **"Develop a comprehensive** program of aeronautical and space activities to be conducted by departments and agencies of the United States.
- **"Designate and fix** responsibility for the direction of major aeronautical and space activities."

Under the Eisenhower Administration, the council was designated and met several times, then became inactive. A full-time council staff provided for in the act was not implemented, and responsibility for planning and developing programs remained with NASA and the Defense Department under the direction of the President.

Edward Welsh, executive director of the council, told the House space committee that the council will not be an operating or executive body in the usual meaning of those terms, but that it will be a management body in the sense that it will assist the President in formulating and executing the national space program.

Supporting a reduction in the membership of the council, Welsh said that rather than have wide representation at all times, consultants or responsible representatives from government agencies will be called in whenever needed.

Welsh said the council staff probably will be composed of no more than 20 people, including 12 to 14 top level staff members. These would not be scientists, he said.

Australia Postpones Helicopter Order

Australian efforts to buy one helicopter to meet requirements of all three services have resulted in postponement of plans for an initial order of 34 Bell HU-1A Iroquois—eight for the Royal Australian Air Force and 26 for the Royal Australian Navy.

Australia had originally programed $10 million for the purchase, which would have narrowed the choice to the Westland Whirlwind (Sikorsky S-55) because of price. But the navy, with an anti-submarine warfare mission requirement, wanted a large twin turbine helicopter—Vertol 107, Sikorsky S-61 or Westland Belvedere.

Army and air force members of the evaluation team which visited the U. S. and England liked the HU-1. At mid-March, the Australian Ministry of Defense found more funds and decided on the Bell helicopter.

The navy, which found all its twin-turbine helicopter choices too expensive, still objected on the ground that the Bell helicopter could not fill the ASW requirement and decided to add more funds for a helicopter more compatible with its mission.

Westland re-entered the picture with a favorable offer of its Napier Gazelle powered Wessex (Sikorsky S-58) and Kaman Aircraft Corp. proposed the H-43B Huskie with an offer to assemble the ship in Australia.

The Wessex, with its ASW capability, is currently favored for the choice, but a new mission representing the three services is expected to be sent to the U. S. and England again to seek a solution.

Project Apollo Flight Advanced One Year

Washington—Redirection of Project Apollo to emphasize early development of a manned earth orbiting laboratory will advance the launching to 1965, one year earlier than planned, the National Aeronautics and Space Administration told Congress last week.

NASA Deputy Administrator Dr. Hugh Dryden said, however, that Fiscal 1962 funding has not been increased over the $29.5 million requested in the Eisenhower Administration budget for feasibility and design studies.

Redirection of the program was revealed by Dr. Dryden during Fiscal 1962 budget authorization hearings before the House Committee on Science and Astronautics. NASA is asking for authority to spend $1.250 billion but is seeking an actual appropriation of only $1.235 billion.

Project Apollo, Dr. Dryden said, has been primarily directed toward developing a spacecraft for manned circumnavigation of the moon which could also be used as an earth orbiting laboratory.

It now seems best to aim early for a space laboratory before continuing on to circumnavigate or land on the moon or to establish a permanent manned space station, he said.

"The reason for this," Dr. Dryden said, "arises out of a recent study of how to do the necessary life sciences work that must be done preparatory to sending man out to the moon. To deal with the problems of radiation and weightlessness it is desired to go beyond three orbits of Mercury and perhaps the 18 orbits of which Mercury is capable, to study the effects on animals and other biological materials in flight over periods of weeks or months if the capability can be developed."

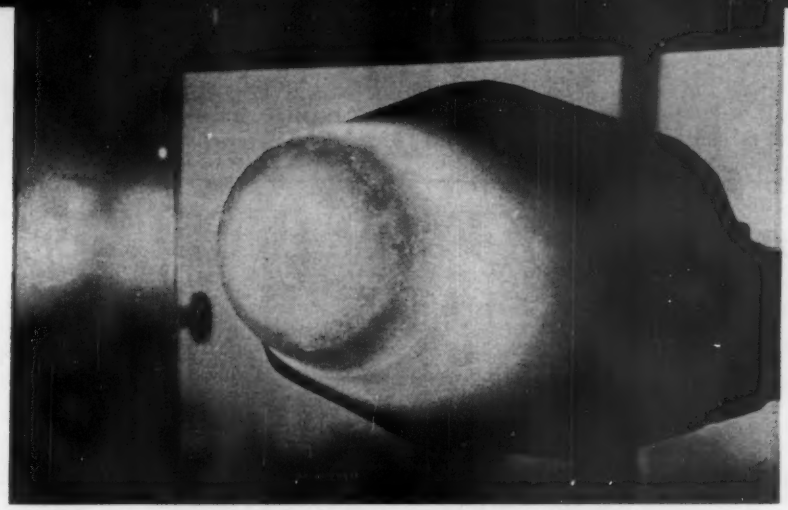
George M. Low, NASA's chief of manned space flight, told the committee that in order to achieve this dual mission capability, it may be desirable to employ the "modular concept" in the design of the Apollo spacecraft (AW Aug. 29, p. 26).

Following completion of the feasibility studies, he said, specifications will be drawn and the detailed design for the spacecraft system will be started.

Fabrication is programed to start in 1963, although this probably could be advanced if the program is accelerated and more funds provided. A developmental flight test program will then be carried out, using Little Joe, Atlas, Atlas-Agena and Saturn boosters.

Results of the Mercury flight test program, he added, will be incorporated into the Apollo design as they become available. In reviewing Project Mercury, Low said that work at both the McDonnell plant and at Atlantic Missile Range is proceeding on a three-shift, seven-day-a-week basis and that all members of the NASA-Defense-industry team are making every effort to meet the target dates established.

Referring to the Fiscal 1962 budget requests, Rep. Overton Brooks (D.-La.) and other members of the committee said they were not satisfied with the amount asked, particularly for solid fuels research. However, Brooks said he did not intend to try to force the Administration to take more money than it asked.



First Photo of Dyna-Soar Nose Cap

Ceramic-type nose cap for Boeing Dyna-Soar manned space vehicle glows white-hot in approximately 3,500F environment of Chance Vought Corp.'s ramjet test facility. Astronautics Division of Chance Vought has a contract from Boeing to develop the Dyna-Soar nose cap to withstand high-temperature re-entry at speeds of approximately 15,000 mph. Astronautics also is designing and will test metal attach rings, heat shields and other structures for fastening the nose cap to the vehicle.

NASA to Brief Firms On Saturn S-II Stage

Washington—System contractor's role for the Saturn S-II stage will be generally described to 20 invited firms by National Aeronautics and Space Administration at a pre-proposal conference Apr. 18 at Marshall Space Flight Center.

As the first phase of a two-part evaluation, the conference will give the companies a chance to decide whether they are interested in pursuing the project further. If so, they will submit initial proposals to Marshall by May 11, outlining their capabilities and past experience.

In the second phase, NASA will select a smaller number of companies, provide them with complete specifications on the S-II and then request detailed proposals, including estimated costs.

The 163-ft. C-1 Saturn vehicle will consist of stages S-I, S-IV and S-V. The follow-on Saturn, C-2, will be a four-stage configuration, with S-II inserted between S-I and S-IV. It is expected to fly in 1964.

Airframe of the S-II will be about 74-ft. long and 21.5 ft. in diameter, and it will be powered by four Rocketdyne J-2 liquid hydrogen-liquid oxygen engines, each developing about 200,000 lb. thrust.

Companies invited to attend are: Avco, Bell Aerospace, Bendix, Boeing, Chance Vought, Chrysler, Convair, Douglas, Firestone Tire & Rubber, General Electric, Hughes, Lockheed, Martin, McDonnell, North American, Northrop, Raytheon, Sperry Rand, United Aircraft Corp. and Western Electric. NASA said other companies which feel that they are capable of the job may contact the Marshall Center Office of Procurement and Contracts for invitations.

In another Saturn development, NASA changed the powerplant arrangement in the S-IV stage from four 17,500-lb. thrust LR-119 engines to six 15,000-lb. thrust LR-115 engines, raising total thrust from 70,000 to 90,000 lb. Both these liquid hydrogen-liquid oxygen engines are made by Pratt & Whitney. Douglas, system contractor for the S-IV stage, said that although the impact of the change was not major, it will necessitate redesign, especially in the propulsion area.

The LR-119 was to have been an uprated version of the basic Centaur LR-115 engine. NASA switched because of the LR-115's more advanced development, better engine-out performance, greater total thrust and better thrust vector control with the six-engine configuration, and the advantage of a common engine for Saturn and Centaur. Two LR-115s have exploded during tests at Pratt & Whitney's Florida facility (AW Feb. 6, p. 31), and difficulties encountered probably would have caused the LR-119 to slip behind Saturn schedules. The company will concentrate on improving LR-115 reliability.

NASA said that two LR-115s also will be substituted for two LR-119s in the S-V stage. Total stage thrust will drop from 35,000 lb. to 30,000 lb., but the total thrust gain of the entire Saturn C-1 vehicle will be 15,000 lb.—because of the 20,000 lb. gained in the S-IV stage. This modified version, NASA said, will have a payload capability of more than 10 tons in low earth orbit.

News Digest

Douglas Aircraft Co. and Piaggio Aircraft Co. of Genoa, Italy have agreed on design and production of a Douglas concept for a light utility jet aircraft, the D-808 (AW Mar. 6, p. 87). Douglas will perform preliminary design at its El Segundo plant and Piaggio will build and market the aircraft abroad. If sales potential warrants, Douglas will build it for the American market. Powerplant probably will be a 2,500 lb. thrust Bristol Siddeley Viper.

West German Defense Ministry will order German-produced versions of the Swiss Cobra anti-tank missile system for use by the German army. Defense Ministry spokesman said the quantity to be ordered is still being negotiated with Bolkow Entwicklungen K. G., the firm producing the Cobra in Germany under license from Contraves-Oerlikon of Switzerland.

H. Don Reynolds, former assistant vice president of American Airlines, has been appointed Traffic Director of International Air Transport Assn., a post vacated last year by John W. S. Brancker.

Bendix Systems Division has a $17.3-million Army contract for continued development of the Project Advent satellite communications system, including orbital and ground elements.

Convair is projecting a short- to medium-range jet transport competitive with the Boeing 727 although formal proposals have not yet been submitted to customer airlines.

North American Aviation will build a rocket-powered, low-speed and zero-altitude ejection catapult system for jet fighters under a $230,000 Air Force contract. Twelve-week test program, using a two-place sled with two dummies, will begin next month at Edwards AFB, Calif.

Aerojet-General's Nuclear Propulsion Division will study design criteria of nuclear propulsion systems, ranging from multimillion pound thrust boosters to smaller-thrust, upper stage powerplants, under a one-year $500,000 USAF contract.

H. Rowan Gaither, Jr., chairman of the group that prepared the still-secret Gaither report on U. S. defense programs and plans in 1957, died in Boston Apr. 7.

New Trunk Competition Faces Profit Test

Earnings potential of reshuffled traffic pattern will be tried in low growth, excess capacity era.

By L. L. Doty

Washington—Domestic trunkline industry, spared a 1960 deficit by a bare $1.1 million profit, will be subjected to a test this year which could prove whether the current major realignment of competition will lend new strength to its earnings powers.

The latest profit total, a decided drop from the $4-million net earnings estimated by the Air Transport Assn. (AW Jan. 22, p. 27) and the $3.8 million forecast by AVIATION WEEK (AW Nov. 21, p. 35), again focuses attention on the current traffic depression and swelling volume of available capacity on competitive routes.

Two recent Civil Aeronautics Board decisions—the Southern Transcontinental Route Case (AW Mar. 20, p. 36) and the United-Capital Merger Case (AW Apr. 10, p. 47)—have drastically revamped the competitive complexion of the industry. The merger case reduces the number of U. S. trunklines from 12 to 11 and creates an airline that reaches into virtually every major airline market in the U. S.

The ultimate effects of the route case undoubtedly will be broad. The decision may eventually make the term Big Four—historically applied to American, Eastern, TWA and United—an obsolete grouping. In effect, it will reshape the industry to create six transcontinental carriers—American, Delta, National, Northwest, TWA and United—and five regional carriers—Eastern, Braniff, Continental, Northeast and Western.

Eastern's Position

Whether Eastern can retain its position as a member of the Big Four depends entirely on its ability to retain its traffic volume. So far, it has not been too successful. Its participation in industry traffic declined 23% from 1955 to 1960, dropping to 13.8% of the industry total last year. In 1960, American's share was 21%, TWA's 15.2% and United's 18.3%.

In the same year, Delta's participation increased 26% to a 6.3% share. Eastern's length of passenger haul and aircraft hop declined in 1960 to a point well below the level of the other Big Four carriers. In addition, the CAB has estimated that diversion of traffic as a result of the merger case will result in a loss to Eastern of some $5.8 million in revenues anually.

The Board estimated that diversion from American will amount to $6-8 million, but American has protested in its petition for reconsideration that diversion will total at least $20-25 million.

Two of the Big Four—Eastern and TWA—showed a deficit for 1960 from domestic operations. In February, United, with a 37% traffic increase, was the only member of the Big Four to show an improvement in passenger revenue miles. TWA was down 31%, American 32% and Eastern 32%. United will report a substantial increase in revenue passenger miles for March, and its merger partner, Capital, also had a traffic rise in February and March.

Profit Peril

Because of the flight engineers' walkout in February, which affected neither United nor Capital (AW Feb. 27, p. 36), it is unrealistic to evaluate the relative standings of the trunklines from a traffic standpoint for the first quarter of the year. The fact remains, however, that early reports indicate the traffic depression has cut deeply into industry revenues during the first three months and that further diversions resulting from increased competition will slice profits of many carriers which, in the past, have shown good earning records.

The new competitive route structure represents a crucial test of the Board's policy of strengthening smaller carriers by improving their competitive positions and allowing them into a wider range of high-density traffic markets. Success of this policy can be reflected only in the number of carriers which show a profit, not in the industry profit as a whole.

Continued losses by any carriers will spell quick disaster in view of the high costs of operating turbine equipment. This poses a strong challenge to managements which must find new ways of opening new markets and imposes increased obligations on the Civil Aeronautics Board, which must regulate competition without damaging individual carriers or the industry as a whole.

Airlines have been highly critical of the Board's policy of increasing competition except in those cases where they have been direct beneficiaries of new route awards. The Southern Transcontinental Case is the last of the major route cases, and thus it is unlikely that drastic changes in the competitive structure of the trunkline industry will be made in the near future unless the Board finds that competition has been spread too thick.

American's View

In a report to stockholders last week, C. R. Smith, president of American Airlines, said that "generally there are already too many carriers on the principal routes and the addition of others will be difficult to justify, but if additions can be justified by 'public convenience and necessity' they should be granted."

Smith admitted in his report that mergers in the past have supplied a "partial solution" to the economic ills of the industry in previous airline depressions, but he added:

"Combining carriers with financial ills and lacking resources to weather the strains inherent in any merger will not serve to strengthen the carriers themselves or the industry. Such ill-conceived mergers may temporarily conceal the basic problem, but they will make the ultimate solution more painful and disruptive."

Smith urged the suspension of service in some areas where there is no longer a need for airline operations as

Eastern-Boeing Trade

New York—Boeing Airplane Co. will purchase 40 DC-7Bs from Eastern Air Lines in what amounts to a trade-in on 40 Boeing 727-25 transports ordered by Eastern. Prices will be low, perhaps scrap value, and Eastern began Jan. 1 to adjust its depreciation charges on DC-7Bs accordingly.

Eastern will sell five additional DC-7Bs, and Boeing will share in the profits or losses of this sale in connection with the five Boeing 720-025 transports which Eastern is purchasing. Eastern will lease 10 other 720s from Prudential Insurance Co. at annual rentals for the fleet of approximately $6,420,000.

one remedy to the current airline depression, and he warned against further fare increases as a cure because of the danger that the market would be narrowed and air transportation might be "priced out" of future growth.

The new competition offered by National and Delta on the southern transcontinental routes and that which will be created by United, with its heavy resources, in markets in the east and southeast will change the distribution of traffic which has been the industry pattern for the past five years. If traffic growth returns to a normal pace or if airline managements are successful in opening new travel markets, the redistribution will give new health to the industry as it is now composed. If traffic growth remains modest for a prolonged period of time, earnings of some carriers may not be sufficient to offset losses of others, which could throw the industry into the red.

Total operating revenues for the trunklines in 1960 reached $1.9 billion, an 8% increase over 1959's revenues of $1.8 billion. Operating expenses climbed 13%—from $1.7 billion in 1959 to $1.9 billion last year. Interest on long-term debt jumped 36%—from $32 million in 1959 to $43.7 million in 1960.

Return on investment for the industry was 2.9%. Profit margin on sales was 0.06%. According to the ATA, the industry's profit margin was five cents on every $83 of sales, compared with the five cents on every dollar averaged by U. S. corporations in general.

Coordination Theme Is Stressed In Kennedy Regulatory Message

Washington—President Kennedy highlighted coordination in his message to Congress last week on the regulatory agencies—which the Administration views as a key factor in its drive to accelerate the nation's pace of economic growth.

Noting the present "compartmentalization" of the activities of Civil Aeronautics Board and other regulatory agencies—"the tendency of each agency to consider only a single industry, or even a single part of an industry"—the President stated:

"This is wrong. The emphasis must now in the national interest be placed upon the health and the practices of a series of industries, rightfully competitive but which—from a national standpoint—must be viewed as a whole."

The Administration's present plan is to allow a period for the coordination to evolve voluntarily and informally among the related agencies—such as CAB and Interstate Commerce Commission. Forceful measures—such as the establishment of a White House "overseer" or coordinator, or legislation requiring coordination will be held in abeyance.

Congressional testimony by CAB has shown that the Board has maintained no contact with ICC.

The President announced that he will shortly recommend legislation to improve the management of regulatory agencies by increasing the authority, responsibility, and accountability of board and commission members and employes. This will include:

• **Additional authority** for the chairman. "Each chairman should be charged with the authority to staff the agency, subject, of course, to civil service requirements, and, in the important posts, to the advice and consent of his colleagues," the message stated. "Each chairman should be made responsible, subject to statutory requirements, for the form of his agency's organization, so as to enable it effectively to dispatch the business before it. It should be his business to review its budget estimates and subsequently to distribute appropriated funds according to major programs and purposes." The chairman would serve at the pleasure of the President—and not for a given term.

• **A "far wider range"** of delegation of work to panels of agency members or to agency employe boards. Their decisions would have "a considerable degree of finality"—and leave for consideration by the full membership of the board only major cases and policy positions. The President noted that in the past two months ICC has delegated to intra-agency boards approximately 18,000 matters which previously required the attention of commissioners.

• **Upgrading of hearing examiners.** "It is my hope that raising the selection standards and increasing the compensation of the hearing examiners will improve both their stature and their general level of competence."

CAB recently put into effect a fourth recommendation by the President: That a Board member assume responsibility for the formulation and presentation of reasoning underlying important decisions. "The practice of rendering anonymous decisions, which has hitherto generally prevailed, has served as a means of escaping precision and responsibility," the President commented. "When the actual source of the opinion is unknown save only that it is issued in the name of the agency, it not only impairs its value as a precedent, but also makes for that very dissipation of responsibility that we are trying to reduce in our administrative action."

The President also issued an executive order convening an Administrative Conference of the U. S. to be composed of jurists, lawyers, and representatives from government and university faculties. The conference would be a continuing body, with a secretariat furnished by the Department of Justice, to review and make recommendations on U.S. administrative procedures.

Hawaiian Regulation Discouraged by CAB

Washington—Hawaii's plan to establish a commission to regulate aviation in the islands has been discouraged by Civil Aeronautics Board Member Whitney Gillilland.

Gillilland told a Hawaiian legislative committee that "the board stands ready . . . to provide any information or assistance that may be of help to the State of Hawaii in matters pertaining to aeronautics."

However, he said, the present coverage of the Federal Aviation Act is so broad that little room remains for state regulation. Under the present scope of CAB jurisdiction, the Board would control common carrier operations between the islands and the mainland, all mail carried by air within the state, all flights between islands, and all intra-island flights transporting passengers or cargo moving in interstate commerce.

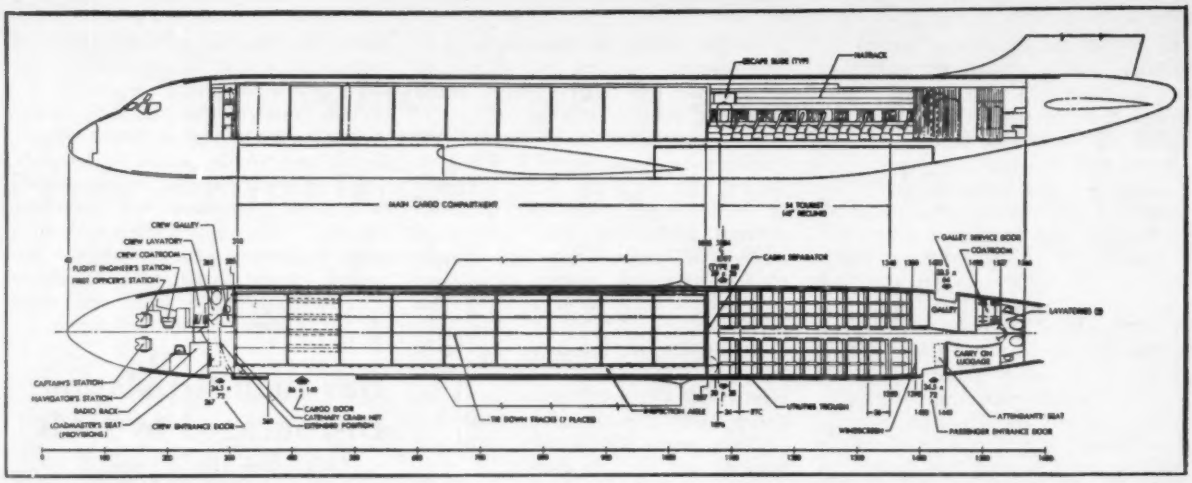
Citing the expense of establishing a duplicate regulatory commission, Gillilland said the two Hawaiian carriers—Aloha and Hawaiian—have formal petitions before the Board estimating future subsidy needs at $3 million annually. He said he assumed Hawaii would want the federal government to pay this bill.

Airlines Plan Reduced New York-Miami Fare

Washington—Eastern, National and Northeast Airlines plan to offer summer excursion fares, with 25% reductions from regular rates, on night coach flights between New York-Miami.

The new fares are to go into effect Apr. 30 on Eastern, May 5 on National and May 8 on Northeast—if the Civil Aeronautics Board approves them. The rates will be in effect until Dec. 15 and are for a round-trip flight completed within 90 days.

The present round-trip night coach fare from New York to Miami is $98 on piston aircraft and $110 on turbojet transports for all three airlines. The new rates will be $73.50 and $85.50 respectively, and they will be in effect Monday through Thursday.



INBOARD PROFILE and interior arrangement of Douglas DC-8F Jet Trader shows main cargo compartment occupying forward two-thirds of cabin, capable of carrying up to 52,000 lb. of cargo, and completely separate aft section configured for 54 tourist-class passengers. Jet Trader, powered by four Pratt & Whitney JT3D-3 turbofan engines each delivering 18,000 lb. static thrust, will have a range of over 7,000 stat. mi., cruising speed of more than 575 mph. and a maximum gross weight of 310,000 lb.

DC-8F Aimed at Jet Cargo Competition

By Russell Hawkes

Los Angeles—Douglas Aircraft Co. has revealed its entry into the commercial turbofan cargo transport competition with a mixed cargo-passenger airplane designated the DC-8F Jet Trader.

Douglas market analysts have long argued (AW May 2, 1960, p. 148) that a massive air cargo business will be brought into existence when the first cargo-carrying jet aircraft go into service. The roadblock to the predicted expansion has been the inability of the existing air cargo market to finance all-cargo jets.

The DC-8F cargo-passenger design is intended to make jet cargo service possible on routes which, at present, do not offer high enough load factors to support all-cargo service. Douglas sets the break-even load factor for the airplane at only 46.3% on over-water routes and 51.5% on domestic runs despite the assumption that lower than current rates would be in effect. The price of the DC-8F will be approximately $6.5 million, according to Donald Douglas, Jr., president of the company.

Douglas engineers gave cargo priority over passengers in the design of the airplane. About two-thirds of the cabin would be reserved for cargo and one-third for passengers. Passenger accomodations are to be coach class because Douglas market analyses indicate that 81% of all airlines passengers now fly coach class.

A strong floor similar to that in the DC-6A cargo plane has been designed for the forward part of the cabin. It is intended to carry 40,000 lb. of bulk cargo loaded on standardized 81 in. x 110 in. pallets. Capacity of the freight section of the cabin is to be nine pallets. The forward and aft cargo pits under the floor will each carry another 7,000 lb., but 2,200 lb. of this capacity must be reserved for passenger baggage.

Cargo will be loaded through a 140-in.-wide door in the left side and at the forward end of the cabin. The side loading design will limit the items which can be loaded to sizes well below what could be put in a swing-tail design. Despite this, air carrier interest in swing-tail designs is fading, according to one industry official questioned by AVIATION WEEK. Air carriers are beginning to conclude that the cost and weight of swing-tail designs are too high.

Boeing also is offering a side-loading turbofan-powered cargo airplane to the airlines (AW Apr. 10, p. 51).

Douglas studies indicate that the best part of the immediate air cargo market is for small items which can be loaded on a standard pallet. To minimize turnaround time, DC-8F cargo will move on fixed rollers and guide rails mounted in the cabin floor. When the load is in position, the pallets will be locked into place on the floor tracks.

The total payload for the DC-8F is to be 62,810 lb., assuming space limited cargo with a density of 10 lb. per cubic foot. It will be able to carry full payload from European cities to New York against winter headwinds. Douglas spokesmen say some restriction on the ratio of cargo to passengers will be set by the necessity of keeping the airplane center of gravity within established limits. If the demand for one service or the other were to be too unbalanced, this might place a restriction on the total payload.

The DC-8F is a fairly standard Series 50 DC-8 airframe, including all the latest wing modifications to improve performance. Engines are Pratt & Whitney JT3D-3 turbofans developing 18,000 lb. static thrust each. The most important wing modification is a sharper leading edge which adds 4% to the chord of the wing throughout its length. The new leading edge can be retrofitted to earlier DC-8s and increases the wing area from 2,773 sq. ft. to 2,868 sq. ft. Late model DC-8s, including the DC-8F, also have redesigned wingtips. Douglas officials claim that the wing modifications and the turbofan engines will increase range by 7%, speed by Mach .02 with no increase in fuel consumption, and in some adverse weather conditions allowable payload will be increased by as much as 7,000 lb. Direct operating costs are to be reduced by 2.2%.

Unlike the other models in the series, the DC-8F will have the aft pressure dome moved 10 ft. further toward the tail to increase cabin length.

First flight of the DC-8F is scheduled for August, 1962, and deliveries could begin by November or December, 1962. Douglas reports that strong interest in the airplane has been expressed by intercontinental operators but no sales have materialized as yet.

Douglas said the DC-8F can carry cargo across the Atlantic profitably at 15 cents per ton-mile—half the current rate. This rate is made possible by the provision for passengers whose fares could be 20% below current economy fares. To equal the revenue potential of the DC-8F, an all-cargo jet would have to carry 92,000 lb. of payload and would be a third again as large as current jet transports. In domestic service, the cargo rate could be cut to 12 cents per ton-mile.

Mexicana Plans to Buy U.S.-Built Jets

By Erwin J. Bulban

Mexico City—Major revisions in the makeup of its jet and piston-engine fleet are planned by Mexicana Airlines to meet increasing foreign competition and provide greater operating efficiencies.

The new program basically calls for adding U. S.-built jets to its de Havilland Comet 4C fleet and reducing the number of types of piston-engine airplanes from four to one.

Mexicana officials told AVIATION WEEK here that they will make a decision on the purchase of additional jet transports within the next 60-90 days.

The airplanes being considered are the Convair 990 and Boeing 720B, which would be used for international flights.

Convair is proposing to lease Mexicana 880s until the time it can make 990 deliveries to the carrier, thus obviating the delay that would be entailed if the Mexican airline had to wait for deliveries of the Boeings. But sources close to the airline feel certain that the Boeing 720B will win the competition. The order would entail purchase of three airplanes.

Indications are that Mexicana officials have been marking time regarding purchase of new equipment, hoping that the Mexican government would approve a plan for an airline consortium, comprising the country's three major carriers—Aeronaves de Mexico, Guest Aerovias and Mexicana—which actually would have led to an even larger purchase of new equipment and would have provided important economies utilizing the airplanes in a pool arrangement.

A detailed proposal regarding such a consortium was made to the government last August by Mexicana General Manager Max Healey, but although a committee composed of representatives of the three carriers and the government was formed some six months ago, to study the program, there has been no indication that the government will make a final decision. The plan is supported by the two privately-owned airlines, Mexicana and Guest—and financial circles say that Mexican Treasury Department officials are extremely interested. But apparently some government officials and executives of nationally-owned and operated Aeronaves de Mexico fear that the carrier will become submerged in the new arrangement. They also fear that the economies it will initially provide may mean a reduction in manpower, an unpopular decision for a government official to have to make in a country where an airline job is considered a premium position.

The consortium proposal indicated that the three airlines could effectively meet equipment needs initially with purchase of six jets, as against a minimum of eight aircraft if they continued to operate as at present. Cost of buying these six airplanes for the pool was estimated at approximately $33.5 million compared with $52.9 million for the fleet required otherwise.

Benefits of such a pool continued to show important economic value from an operations standpoint—Healey estimated that Aeronaves could lower its utilization requirement from 89% to 73.3%, Guest would require 64.3% utilization rather than 70.2% and Mexicana's utilization requirement would drop the least—from 57.7% to 56.2%.

The study also indicated that the total monthly operating cost of the six aircraft by the pool would amount to approximately $3.6 million, including amortization and administrative costs, plus a charge of $184 per hour for use of pooled aircraft and an additional 10% cushion, based on present route patterns.

Another benefit of a consortium arrangement would be that the three carriers together could afford purchase of ground simulators—which Mexicana says is prohibitive for any of them to do alone. Jet training now is done in the actual aircraft. According to the study, a pooled simulator could handle 80% of this training and provide savings of at least 15-20% over current methods.

Observers of the Mexican government airline say that it has been experiencing heavy deficits—its Mexico-New York operations with Bristol Britannias reportedly have a poor financial record in the face of more modern jet equipment. Its only DC-8 crashed at Idlewild last winter (AW Jan. 30, p. 43) shortly after it went into operation and has not yet been replaced.

The country's two independent carriers in the interim have developed an aircraft pool operation with the Comet 4Cs purchased by Mexicana that highlights the possibilities of the proposed consortium. Mexicana's three Comet 4Cs—a fourth will be delivered this summer—are experiencing a daily utilization of approximately 12 hr.

Typical of this utilization is the fact that with only three Comets now operating, Mexicana provides once-daily round-trip service from Mexico City to Los Angeles and Chicago, three-times weekly to San Antonio and three times weekly to Dallas—and in addition, the airplanes are operated by Guest Aerovias on transatlantic service from Mexico City on a three-times weekly round-trip to Paris, with stops in Miami, Bermuda, Santa Maria, Lisbon and Madrid. The Guest flight leaving Mexico City on Monday, for example, arrives from Paris Wednesday morning at 11:50 and then is rescheduled for the Dallas round trip, leaving Mexico City at 3:50 that afternoon.

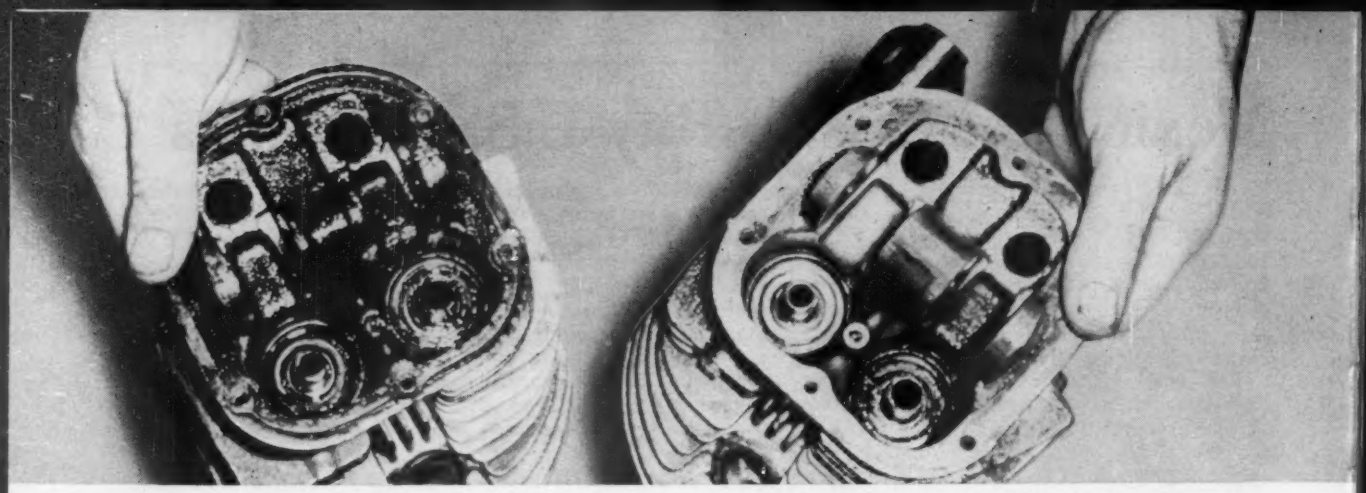
Mexicana's current plans call for reducing its equipment types to two —the Comet 4C and the Douglas DC-6. It currently has eight DC-6s, seven DC-4s, 16 DC-3s and three Fairchild C-82s (modified all-cargo aircraft). Divesting itself of the other aircraft has been a slow process, largely because of the poor market in used aircraft. It has modified a DC-3 into an executive airplane and plans to send it on a sales tour of South America, and would convert others to this configuration if a market develops. The C-82s probably will be sold for scrap, with the engines removed. These airplanes are powered by DC-6 powerplants which could be put into that airplane's spares inventory. The carrier also owns three DC-7Cs, which it bought in anticipation of getting service to New York. This was granted to Aeronaves instead, and Mexicana has leased two of the DC-7Cs to Northwest Airlines and one to Pan American Airways.

Mexicana Airlines Revenues & Expenses

1954-1960

Year	Gross Revenues	Expenses
1954	$12.4 million	$11.9 million
1955	14.5 million	13.1 million
1956	16.2 million	15.0 million
1957	18.1 million	18.3 million
1958	20.6 million	20.5 million
1959	19.9 million	20.2 million
1960	21.6 million	21.8 million

Data is in U. S. dollars.



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7. Is AeroShell Oil W thoroughly proved? Thoroughly. It's had millions of engine hours of flight time.

8. Where is it available? At Shell Aviation Dealers everywhere. *Any* dealer will stock AeroShell Oil W if you ask for it.

9. Can I add AeroShell Oil W as a make-up oil? Yes. It is compatible with all piston engine oils now being used.

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Atlantic Lines Fight Canadian Traffic Fee

By Robert H. Cook

Washington—Canadian demands that transatlantic carriers triple their payments for radio and navigation aids are meeting stiff resistance from major U. S. and foreign flag airlines, who fear that compliance may pave the way for a world wide system of user charges.

Charged with the responsibility for air traffic control over the northwest sector of the Atlantic Ocean, the Canadian government levied a fee of $13 per flight for each airline using the facilities in 1950, raised the price to $20 without any carrier complaints in 1953, but met with immediate opposition when it began to demand $84 for each flight in January, 1960.

Since then, eight of the airlines affected have continued to pay the $20 charge but have flatly refused to pay the additional $64, with the result that the Canadian government now contends these airlines owe an estimated $1.5 million in unpaid charges.

Pan American World Airways, Trans World Airlines, the Flying Tiger Line and Seaboard & Western Airlines are fighting the extra charge, along with Scandinavian Airlines System, Swissair, Sabena and KLM. British Overseas Airways Corp., Air France and Lufthansa are among the foreign carriers who have agreed to the increase.

Payments Withheld

TWA paid a fee of $76,000 last year, but withheld $217,000 which would have been collected under the increase. Pan American also made payments on the basis of a $20 fee and withheld a total of $362,000. Flying Tiger estimates the rate increase would have cost $10,000 last year.

After more than a year of debating between Canada and the governments of the other countries involved, the International Air Transport Assn. and the Civil Aeronautics Board, no solution appears in sight. The objecting airlines are facing the possibility that Canada might sue to capture the extra funds it is claiming.

Canada has keyed its increased airways user charge to offset heavy losses, which it claims are being incurred by continued operation of its Gander, Newfoundland, air traffic control center for the northwest Atlantic. The Ministry of Transport claims an annual expense of more than $1 million to keep this facility in operation for their emergency commercial use or frequent use by the military aircraft of both Canada and the U. S.

Revenue formerly collected from piston-engine aircraft landing fees has literally "disappeared," Canadian officals say, because of the long-range capabilities of turbojet aircraft, which permit them to overfly Gander.

About 50% of the cost of operating Gander is deducted from its budget to cover military operations leaving the balance to be recovered from commercial operations. The $64 increase is considered about enough to handle the cost of a transatlantic flight, the Ministry of Transport says.

U. S. Carriers Indignant

U. S. carriers objecting to the extra charge point out that the U. S. has no similar airways user charge for other countries, and they express indignation that Canada has taken such a course since "much of this equipment" was given to the Canadian government during World War II to establish departure points for transatlantic military flights. Canada does not agree on what items of radio and navigational aid were purchased or donated and observes that it is still faced with the mounting costs of operating facilities "of little use to Canada" and which do not pay their own way.

Objecting airlines fear that agreement to the user charge increase may signal a flood of similar actions by other governments. Should this become effective on a global basis they claim, the annual operational costs of all international airlines could be increased as much as $150 million.

Lending some credence to this concern is the fact that Ireland is faced with much the same problem because of a drop in traffic at Shannon. Syria, Formosa, and Burma already have decided to impose overflight charges, and several other nations have considered the matter.

Hazard to U. S.

Should the current situation develop into a user charge contest between the various nations, observers contend that the U. S. may find itself "subsidizing the rest of the world's airlines" since most of the foreign flag carriers are government-owned and supported. Any agreement to impose an across-the-board scale of charges would have the net effect of drawing dollars into other countries in opposition to the present Administration effort to halt the flow of gold from the U. S.

Two solutions appear possible to settle the question in the near future—rearrangement or transfer of the air traffic control zone controlled by Canada or an agreement which would place this responsibility in the hands of all nations using transatlantic routes.

To remove the threat of a "toll gate" across the Atlantic an agreement giving the U. S. responsibility for an expanded air traffic control area, which would include the Gander area to the north, could be undertaken at U. S. expense. This could be accomplished by an International Civil Aviation Organization ruling shifting the southern boundary of the Canadian-controlled sector from the present 40 deg. parallel to the 50 deg. parallel.

A more likely solution, which the airlines are hoping to achieve, is joint operation of traffic control facilities in the northwest Atlantic area. Maintenance and operational costs would be prorated among the nations using the aids. Such joint support agreements are now in effect for the fleet of Atlantic weather and position advisory ships in the Atlantic, in addition to weather facilities on Greenland and navigation aids in Iceland and the Faroes Islands.

Examiner Urges Halt Of Seaboard Practice

Washington—Seaboard & Western Airlines will have to stop carrying commercial cargo and mail on military charter flights if Civil Aeronautics Board accepts its examiner's decision.

The examiner recommended that Seaboard halt this practice in reporting on a complaint, filed by Trans World Airlines and charging that Seaboard has violated the Federal Aviation Act by carrying cargo and mail in unused cargo space aboard military charter cargo flights.

TWA said this mixture of scheduled and charter operations diverts "large amounts of mail and cargo," causes "substantial injury" and involves "unfair and deceptive practices."

Seaboard, which is certificated for scheduled operation between points in the eastern U. S., Newfoundland and Europe, did not deny the allegations but contended the operations are legal. The Air Force contract for the charter flights between the U. S. and Europe, Seaboard said, was let on the basis of an "available cabin load" with a specified minimum to be carried. Beyond this minimum load, Seaboard argues that the contract does not specify how left-over space is to be used, but it does say that regular CAB economic regulations apply unless exempted.

In his decision, the examiner concluded that CAB regulatory restrictions still apply to the carrier and that no mixture of charter and commercial operations was contemplated in the contract.

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SHORTLINES

► **Aeroflot,** the Soviet airline, began service Apr. 3 with Il-18 turboprop aircraft between Moscow and Kabul, the capital of Afghanistan.

► **American Airlines** will increase capacity of its Boeing 707s and 720s May 1 by increasing the proportion of coach seats. The 707s will carry 120 passengers and 720s will hold 104, a gain of two seats per aircraft respectively.

► **Braniff Airways** has negotiated a contract with the International Assn. of Machinists giving maintenance workers pay raises of 10 to 15 cents an hour retroactive to Oct. 1, and another eight cents next Oct. 1.

► **Continental Air Lines** has asked Civil Aeronautics Board to add San Diego and San Francisco/Oakland to its Houston-Los Angeles route, recently awarded in the Southern Transcontinental Route Case.

► **Delta Air Lines** will begin DC-6 coach service Apr. 30 from Miami to Asheville, N. C. via Tampa and Jacksonville.

► **New York Airways'** five Boeing-Vertol 44 helicopters each have logged more than 4,000 hr.

► **Northeast Airlines** carried 150,000 passengers last month, a 50% gain over the same month last year. Northeast credits the introduction of Convair 880 turbojet service for part of the increase.

► **Pacific Northern Airlines** has ordered two Boeing 720 turbojet transports, to be delivered in the spring of 1962. The aircraft will fly between points in the Pacific Northwest and Alaska.

► **Pan American World Airways** plans to make 10,000 seats available on 158 weekly flights between the U.S. and Europe for peak summer travel.

► **Sabena Belgian World Airlines** reports it carried 89,261 passengers between the Congo and Belgium in 1960, compared with 54,108 in 1959.

► **Trans World Airlines'** authority to suspend service to Manila has been extended one year by the CAB.

► **United Air Lines** will begin daily through service from New York to Honolulu Apr. 30 and from Chicago to Honolulu June 10. The DC-8 flights will be operated via San Francisco and will take 11 hr. 25 min. New York-Honolulu and 10 hr. 10 min. Chicago-Honolulu.

AIRLINE OBSERVER

► Feeling that present turbojet aircraft will have a longer useful life than originally expected is growing in some airline and financial circles. American Airlines, for example, changed the estimated useful life of its jet transports from 10 to 12 yr. for depreciation purposes, effective Jan. 1. In part, the change was due to the added useful life provided by conversion of American's fleet to turbofan engines, but the move also represents a change in the carrier's estimate of general life expectancy. Despite talk of supersonic transports, a number of U.S. carriers see no replacement for current large jet aircraft on the horizon.

► **High frequency of operation that will be necessary to make a supersonic transport pay will accentuate a problem already existing with subsonic jets—tire failure. Pan American World Airways, for example, has experienced one tire removal for every 12 jet landings. Supersonic transport operation over long ranges will be more like short-haul service than current long-range service because of the increased number of landings. Engineers believe that landing gear structural margins also will have to be increased in supersonic operation.**

► Civil Aeronautics Board members themselves, rather than the general counsel, will now write opinions in formal hearing cases. Under the new procedure the Board chairman will assign individual members with the responsibility for preparing an opinion and submitting it to the Board for approval. Each opinion will be issued in the name of the member responsible, followed by the concurrence of other members. Board chairman will share the opinion-writing job.

► **Lake Central Airlines, which is showing growing interest in conducting helicopter operations in metropolitan areas, has completed an evaluation of the Boeing Vertol 107 prototype helicopter powered with two General Electric T58 gas turbine engines. Evaluation included a nine-day series of flights with the 107 throughout Lake Central's system.**

► Further analysis of Convair 990 flight test data by the company's dynamics laboratory reveals that the oscillations of the outboard engine pods did damp out, contrary to first reports. Maximum amplitude of the oscillations was ⅛ in. Decision to shorten the pods still stands, however, because the damping of the oscillations was not rapid enough to be considered safe by Convair's engineering staff.

► **Civil Aeronautics Board Bureau of Air Operations has asked State Department to reconsider its stand that the bilateral air transport agreement between the U.S. and Australia calls for a Tahiti stop by Qantas Empire Airways. Bureau holds that testimony in hearings on the Qantas application for the Tahiti service "has effectively neutralized the grounds for State's position."**

► U.S. and Denmark have signed an agreement under which the U.S. will provide international air traffic control services over Denmark's Greenland and its territorial waters. U.S. Air Force will provide the service at Sondre Stomfjord Air Base and Thule Air Base for commercial aircraft operating over the North Atlantic polar route.

► **American Airlines will furlough 75 copilots May 15 in a cutback resulting from the six-month-to-a-year slip in the development of the Convair 990 (AW Mar. 27, p. 38) and the loss of southern transcontinental interchange agreements stemming from the recent decision in the Southern Transcontinental Route Case.**

► Russia's new An-24 turboprop transport is now undergoing final flight tests and is scheduled to appear on passenger routes shortly.

► **International Air Transport Assn. traffic conference will reconvene in Montreal May 1 to negotiate new Atlantic air cargo rate agreements. Existing agreements have been extended until June 30 to block the threat of a rate war.**

► American Airlines will overhaul and convert 29 Pratt & Whitney JT3C-6 engines for Qantas Empire Airways to forward fan configuration. The converted JT3MC-6 engines will be installed on Qantas' Boeing 707 fleet.

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AW 670 Would Carry 8 Cars, 32 Passengers

London – Armstrong Whitworth plans to develop an air ferry variant of the AW 670 series designed to carry eight cars on a lower deck with 32 passengers on an upper deck. An air bus variant is proposed with a capacity for 114 passengers.

Armstrong Whitworth originally proposed an AW 670 air ferry with capacity for six cars and 30 passengers (AW Feb. 20, p. 37).

A new undercarriage is the main structural change. It has been designed as a fixed installation for the air ferry version but can be swiftly converted to a retractable system for air bus operations.

For air-ferry operations, which might involve a landing every half hour throughout the day, a fixed undercarriage would simplify maintenance.

Refueling points in the undercarriage legs will be designed to speed turnaround times and avoid interference with passengers and cars during fueling. Rows of cars would be loaded and unloaded simultaneously in both directions, using the straight-through loading feature of the Argosy fuselage.

Main hold of the 670 series is increased to 58-ft. long, 15-ft. wide and 7-ft. high, increasing to 9 ft. 2 in. high aft of the wing.

In air-ferry form, the AW 670 would carry a 25,000-lb. payload for 140 naut. mi. or 20,000 lb. for 420 naut. mi., with full allowances in each case. The air bus would carry 20,000 lb. for 350 naut. mi. with full allowances.

Supplemental Groups Consolidate Functions

Washington–Supplemental airlines moved last week to strengthen their position in the competition with scheduled airlines for international charters by consolidating the functions of their two industry groups–the Independent Airlines Assn. and the Supplemental Air Carrier Conference.

Terms of the consolidation agreement, which must be approved by 24 carriers at a joint meeting June 21, call for IAA to discontinue its trade association functions and concentrate on traffic procurement and the operation of its air traffic exchange service for both organizations. SACC will serve as the supplemental industry's spokesman in public, congressional and governmental matters.

Both associations would retain their present names, with Clayton L. Burwell, president of IAA, serving as president of both groups and with Alwyn Matthews, president of SACC, serving as executive vice president of the combined operation.

Approval of the consolidation by member airlines would eliminate growing duplication between the two organizations, Burwell said. IAA and SACC both have maintained competing facilities at about 40 military bases, he said, and SACC recently received authority to operate an air charter exchange service similar to the IAA service.

Burwell emphasized that the combined organization will continue to seek new legislation giving supplemental airlines permanent operating authority. Last year, a U. S. Court of Appeals ruling held that the Civil Aeronautics Board had exceeded its authority in granting certificates to the supplementals by limiting their schedule frequencies and failing to require that the carriers name the cities to be served.

Congress later passed interim legislation maintaining the status quo of the supplementals for a 20-month period and indicated it would investigate the industry's problems during the 1961 session, Burwell noted.

Senate and House aviation subcommittees have not scheduled any hearings on the supplementals this year, but they point out that hearings can be held when considered necessary.

Local Airline Service Described by ALTA

Washington–Assn. of Local Transport Airlines hopes to strengthen its defense of the local service industry's mounting subsidy bill by presenting each member of Congress with a special report this week on the increasing value of public benefits provided by the subsidized carriers.

Current issue of the report, prepared for ALTA by Planning Research Corp., emphasizes that while the industry's annual subsidy bill has increased, local service airlines have doubled their route mileage during the past decade and have cut the required subsidy per passenger in half. The industry carried nearly 6 million passengers over a total route system of 32,000 mi. last year, with an estimated subsidy cost of $53 million.

As trunk airlines and railroads both reduced their local services in the past 10 yr., the report said, the local service industry filled this "transportation gap," increasing its total route mileage 101% and cities served 90%. Trunk route mileage during this period increased only 13%, while the larger airlines had a 25% reduction in the number of cities served exclusively by them. Between 1949 and 1959, railroad passenger service for Class I railroads dropped 41% from 380 million passenger train miles, the survey noted.

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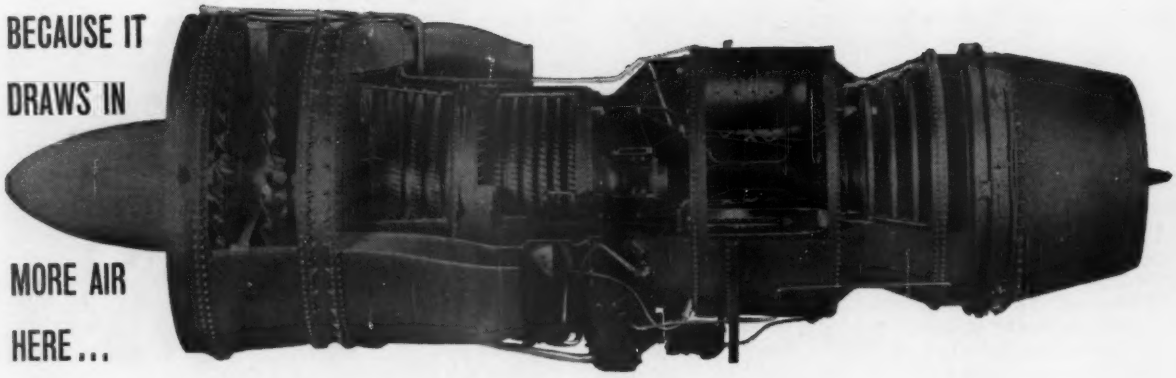

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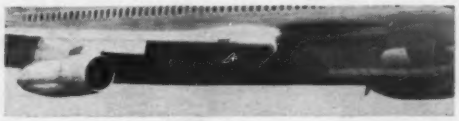

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FAA Is Revising Used Transport TBO's

By David H. Hoffman

Indianapolis—Chances are strong that airlines buying used transports will be able to trim their maintenance budgets substantially under more precise and more flexible overhaul time control systems now being developed by Federal Aviation Agency.

Although FAA has just begun to tackle the problem of fixing times between overhaul (TBO) for used equipment, it is apparent that the agency plans a fresh approach with an across-the-board stretching of TBOs as a major goal.

FAA Study Teams

Specifically, FAA study teams will take their first close look at the pros and cons of:

• **Drafting sets of common** TBO specifications for such frequently traded transports as the Douglas DC-3 and DC-4 and the Curtiss C-46. These "common specs" would govern how long the buyer could operate the seller's equipment before overhauling it. They might also establish the buyer's first full TBO period after an initial overhaul had been accomplished.

• **Establishing** Maintenance Review Board to fix starting overhaul times for new operators of old equipment. Armed with the local field inspector's recommendation, the board members would assess the buyer's maintenance capability and grant TBOs accordingly. Or, instead of duplicating the purpose of the common specs, the board might serve strictly as an appeals group.

• **Issuing a rule** under which the seller's TBO, if it were higher, would pass automatically to the buyer. FAA then would keep a close watch on the buyer's entire operation to ensure that maintenance techniques are sound and that failure rates remain at a safe level.

FAA Solicits Aid

To win industry approval for the system it ultimately selects, FAA is seeking technical advice from the airlines, especially from those shopping for piston transports made available by the trunklines' transition to jets. In soliciting this aid, FAA emphasizes that it wants to "get out of the airline business" by giving carriers more freedom to fix their own TBOs.

Authorized TBOs for airframes, engines and components passing from one owner to another have been determined by a tangle of criteria that seemed to vary from region to region and from airline to airline. Because such criteria were circulated by in-house memoranda and because local inspectors were entrusted with wide discretionary powers, the situation grew so confused that even FAA cannot always explain how certain TBOs were arrived it. In broad outline, however, here is the current procedure:

When airline A buys aircraft and engines from airline B, a new overhaul time control program is established by FAA and included in the purchaser's operating specifications. Disregarding the engine TBO earned by airline B, FAA rolls back airline A's allowed time to correspond with a list of "basic" TBOs covering 14 of the most common powerplants in airline service. A similar system is applied to airframes, except that there is no formal time listing and a basic figure of 10,000 hr. is often used.

TBOs established in this manner come into play only after the buyer has completed his initial overhaul. To determine how long airline A can operate airline B's old equipment before first overhaul, FAA prorates the hours remaining at the time of sale.

As an illustration of the system in action, Riddle Airlines recently purchased seven Douglas DC-7Cs through General Aircraft & Leasing Division of General Dynamics. The Curtiss-Wright TC18 engines on the aircraft were being overhauled either at or above the 1,500-hr. mark by the former operators. Riddle's TC18 TBO, however, was set at 1,000 hr., despite the fact that the manufacturer, Curtiss-Wright, had contracted to perform all overhaul.

To pro-rate the time remaining on each DC-7C airframe, FAA converted the number of hours the seller already had used to a percentage of the total hours allowable. This percentage then was applied to the new airframe TBO that FAA had awarded Riddle. The percentage that remained, reduced to hours, told Riddle how long it could fly each transport before overhaul was required again. Each engine and many of the components purchased by Riddle underwent identical prorating processes.

Analyzing this system, airlines aim most of their complaints at the rigid basic overhaul periods established for engines and at whatever criteria FAA uses to determine comparable periods for airframes. Carriers claim that the basic engine TBOs—1,400 hr. for the Rolls-Royce Dart, 1,300 for the Pratt & Whitney R2000, 1,200 hr. for the Pratt & Whitney R1830 and 1,000 hr. for the Allison 501-D13, to cite a few examples—are far too low. They also argue that the airframe criteria lack uniformity and are kept secret by the Federal Aviation Agency.

When a trunkline disposes of surplus equipment, it often contracts to do major maintenance and overhaul work for the purchaser. The trunkline also usually trains the purchaser's aircrews and furnishes the purchaser with detailed operating and maintenance instructions to ensure full utilization of the equipment.

As a result of such sales, there can be very little difference between how the equipment was operated by the seller and how it will be operated by the purchaser, airlines believe. Thus, they feel that a greater portion of the trunkline's TBO should be passed on to small airline purchasers.

When this is not done, carriers contend that:

• **Small airlines,** operating on tight budgets and lacking large maintenance installations, cannot afford to improve their fleets and elect to lease new equipment rather than purchase it.

• **Used aircraft market** turns increasingly soft because the higher cost of maintaining new equipment cancels its extra productivity, thus discouraging sales.

• **New owners of old** aircraft resort to "less reliable" and less costly contractors in an effort to maintain their new equipment as cheaply as possible.

Mackey's Experience

Mackey Airlines, for example, acquired an American Airlines Douglas DC-6 through Frederick B. Ayer and Associates. Engines on the DC-6 were overhauled every 2,000 hr. by American, but Mackey's basic TBO was cut to 1,400 hr.

This increased the cost of a single four-engine overhaul by about $22,000 and forced Mackey to return the aircraft after a year's operation.

Col. Joseph C. Mackey, president of the airline, found the 600-hr. TBO loss particularly objectionable because his airline flew the transport at less than its maximum performance capabilities. Mackey air crews used 100 hp. less than American in cruise, used less than rated power on takeoff and generally operated the aircraft well below its maximum gross weight. This type of operation, less demanding on both engines and airframe, should have been reflected by longer TBOs, Mackey maintains.

Against this background, FAA's Bureau of Flight Standards invited interested airlines here Apr. 5 and 6 to "explore reasonable ways and means of establishing overhaul time limitations and inspection intervals for airframes, engines, propellers, appliances and components on aircraft which have been transferred from one air carrier to an-

Trans World Airlines' Convair 880 Fleet Grows

Convair 880 jet transports being readied for delivery to TWA are shown at Convair plant in San Diego. Airline has received 12 of the planes, expects to get the last of 20 by Aug. 10. Another six are on lease from Hughes Tool Co. to Northeast Airlines; four more are still contracted for by Hughes but not assigned to TWA. The 880s are serving nine TWA cities, including a New York-St. Louis nonstop schedule. Typical additional cities will be Tulsa, Oklahoma City, Albuquerque. One operation being performed on the Convair ramp is putting on the tail cap; this cannot be done on the production line because of roof height.

other under sale, lease or other arrangements." Representatives of more than 15 airlines, the Air Transport Assn. and Allison Division of General Motors responded.

At the conference, FAA officials, including George C. Prill, deputy director of the bureau, promised to "thoroughly explore" the ideas of a common specification for old airfreighters and a Maintenance Review Board (MRB). Both FAA and the airlines agreed that the meeting was "surprisingly productive." Although Prill refused to predict when the new ideas might become the subject of formal FAA rulemaking, he did say that TBOs would receive the concentrated attention of his bureau.

Proposed by A. W. Dallas of ATA's engineering department, the MRB would be a permanent body based in Washington. Very similar to the type of board that now sets initial TBOs for new aircraft and engines, the MRB for traded equipment would judge each case on its merits. Thus, it could afford to be less conservative than FAA has been in preparing blanket lists of basic overhaul times for the industry, Dallas said.

MRB Membership

To lend continuity to its decisions, MRB membership would be reasonably permanent. One type of decision it might issue would be a preliminary judgment designed to give an airline on the verge of making a purchase some indication of the initial TBOs to be expected. On the basis of this preliminary finding, the airline might better be able to gage the financial strain of acquiring new equipment.

But remarks of FAA officials at the conference here indicated that the MRB and the common spec would play relatively minor roles in the agency's over-all effort to reshape maintenance control policies. Prill traced these outlines of the new philosophy for AVIATION WEEK:

FAA's regulatory efforts in the maintenance area have varied between issuing precise rules, such as aircraft performance requirements, that allowed little in the way of interpretation and issuing general rules that offer few specific guides.

The current trend is to synthesize these two approaches. FAA wants to leave the techniques of maintenance up to the airlines, but it also wants to devise sets of precise criteria for grading the end product. The agency refers to this end product as an airline's "performance level" and, as far as engines are concerned, uses a formula to determine it.

Published as a proposed rule in the Federal Register—comment is due on May 8—the formula defines performance level as the number of adjusted engine failures occurring during 1,000 hr. of engine operation. Total engine failures minus failures caused by foreign object ingestion, personnel error or malfunctioning components equal adjusted failures.

Under the proposed rule and under present practice (AW May 9, p. 38 and Dec. 12, p. 45), airlines can advance turbine engine TBOs 100 hr. if their adjusted failure rate for a 90-day period is 0.15 per 1,000 engine hr. or less. Comparable figure for piston engines is 0.4 per 1,000 hr.

FAA's formula approach to TBO control, referred to as "the numbers game" within the industry, has drawn a steady stream of criticism from the airlines. They contend that the formula, in effect, considers all engine failures inherently dangerous, while this is not the case with four-engine transports.

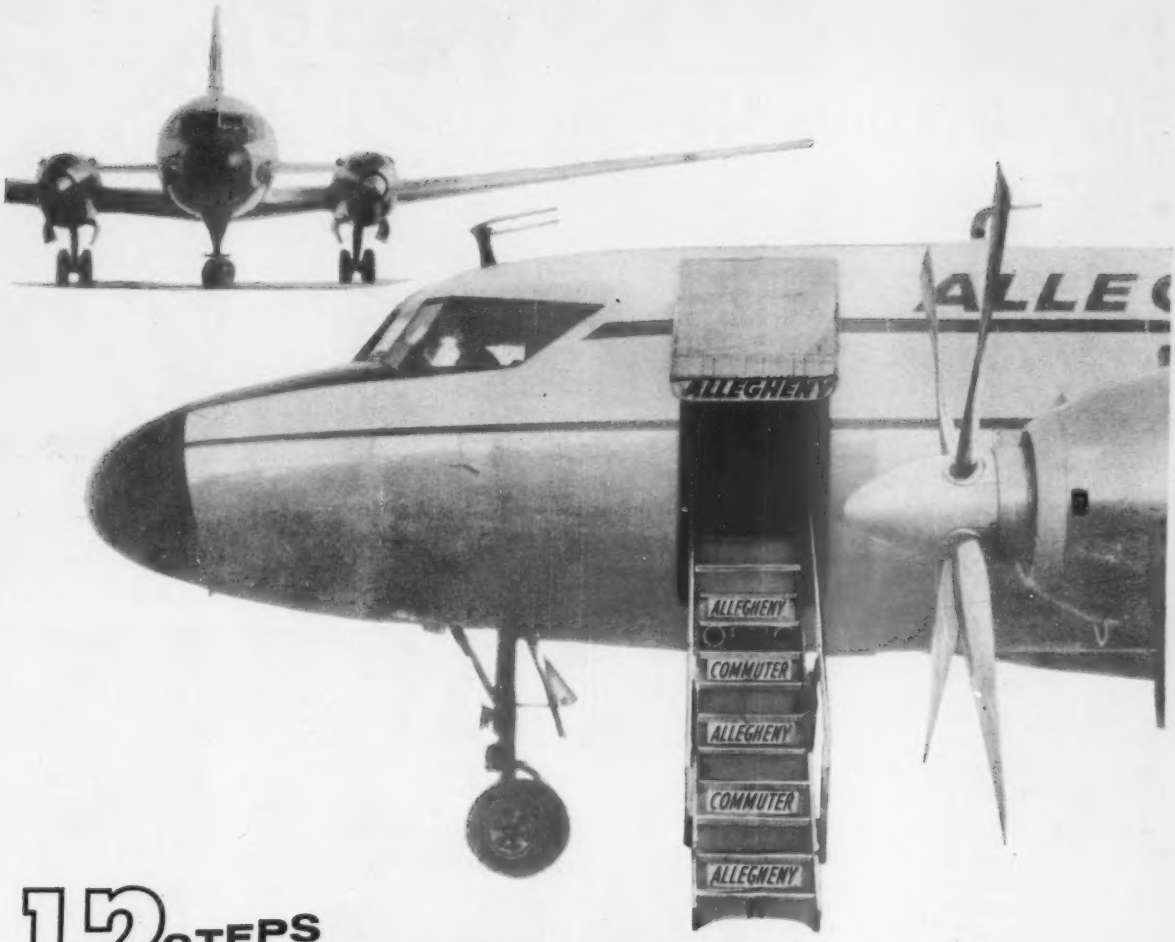
Prill counters that organizations with more built-in flexibility, and with more discretion at the local level, assume that the agency's 200-odd field inspectors are "universal geniuses" and that they all agree with one another. Because this is obviously untrue, the workable system must be based on common guides that apply equally to all carriers. This is the reason for the performance level formula.

More Latitude

At the same time, Prill would grant the airlines considerably more latitude in fixing their initial TBOs, especially those applicable to old and proven equipment. If their failure rates later should climb higher than those allowed by the various formulas, TBOs would be reduced.

In the future, Prill believes, precise criteria may be developed to control the overhaul times of even basic structural components, such as landing gear and wing sections. This will hinge on improved systems for collecting data on part failure rates and on analysis of the causes of the failures, he said.

To begin gathering such data, FAA plans to tighten up the system under which airlines submit Daily Mechanical Reports (DMRs). It also plans to equip one of its turbojet transports with a special maintenance flight recorder which will measure the effect of some 200 external forces on the safe life of the aircraft (AW Apr. 10, p. 51).



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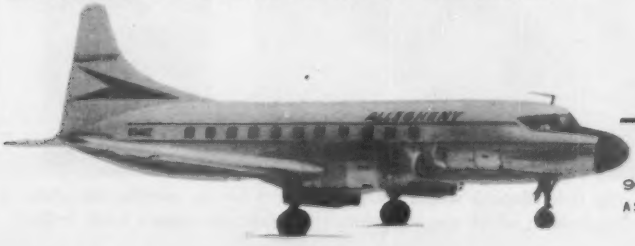

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Special Tools Designed for Use in Space

Dallas, Tex.—Design and use of tools for assembly and repair of earth-orbiting platforms and other space vehicles is being studied here at Chance Vought Corp.'s Astronautics Division, which already has designed and built early working models of space tools.

Development of these tools, admittedly crude "breadboard" models of what may actually be used, involves not only their mechanical design but requires that human orientation and body control in a weightless environment is taken into account, according to Dr. Charles F. Gell, chief of life sciences for the Astronautics Division. Space repairmen, for example, probably will have to undergo training to re-orient their habitual ways of using muscles to perform various work assignments, study muscle interaction and utilize stabilization equipment to perform their new jobs.

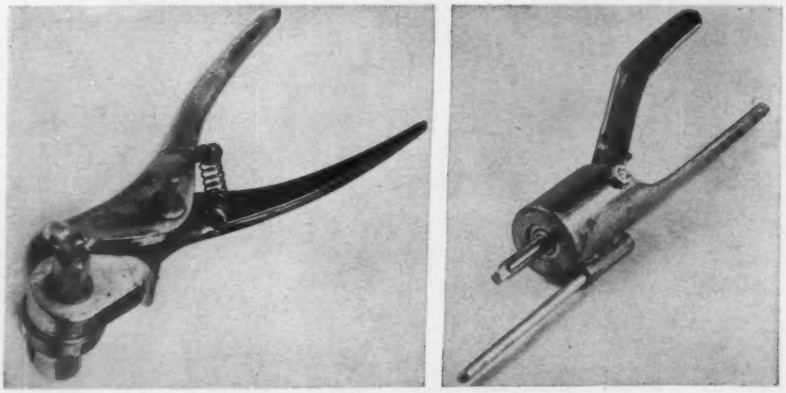
An abrupt arm movement, for example, would be enough to place a man in motion in a weightless environment and alter his center of gravity, Dr. Gell notes.

Early "space tools" developed here utilize squeeze principle for their operation, since twisting a screwdriver, for example, in a space environment would merely set the repairman spinning. Items studied thus far include squeeze-type screwdriver, socket wrench, and a "plench"—a combination plier and wrench.

In development of the plench, it has been learned that considerable assistance is provided the operator if the work area is fitted with points in which a pin on the plench can be inserted to provide leverage and positioning.

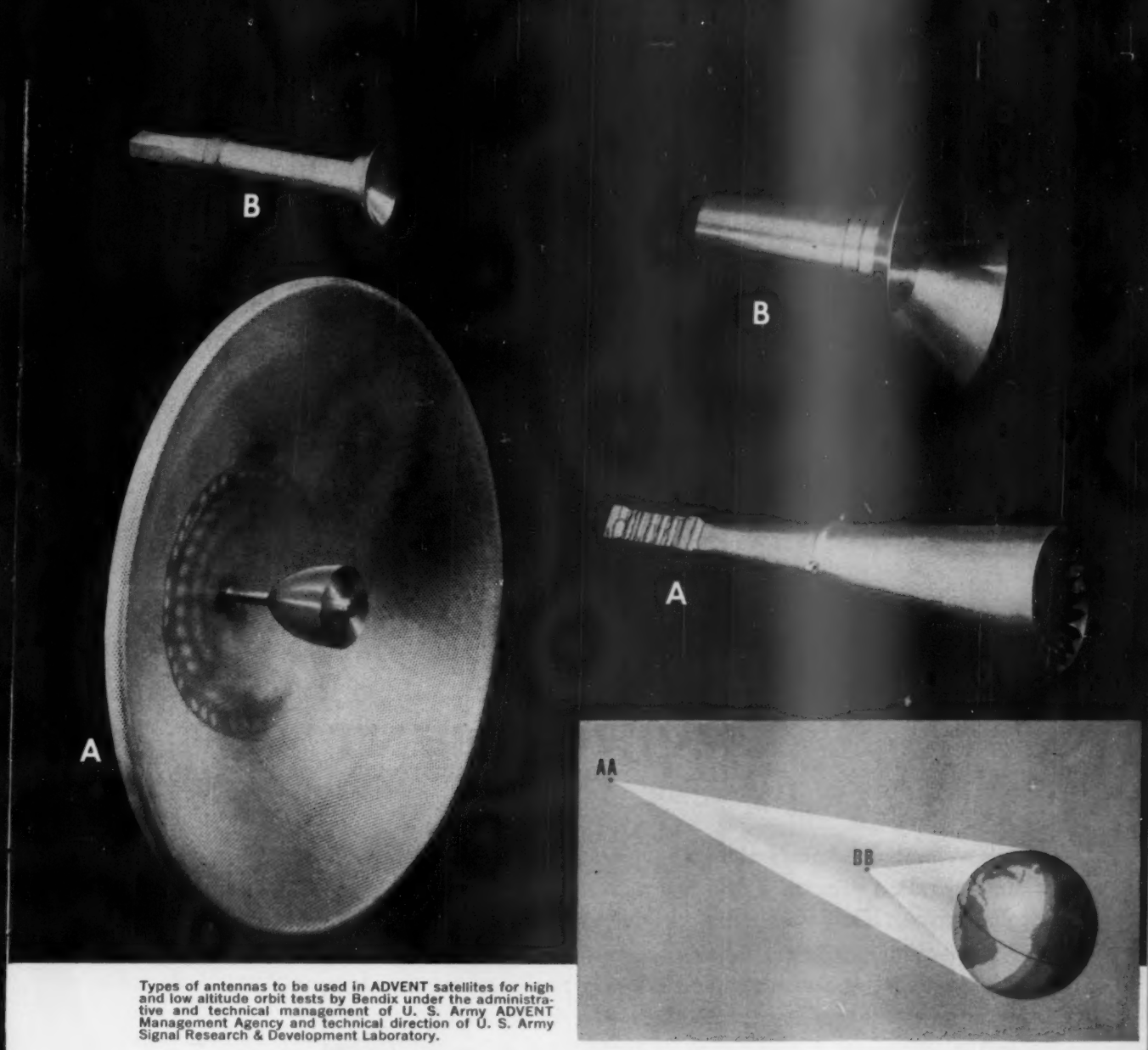
Also, Chance Vought engineers believe that some form of hand-hold will be necessary for operators—this may take the form of a magnetic device that can be placed against the area where the work is to be performed to provide anchorage for the weightless repairman working outside the space vehicle or space platform.

To assist in its studies, Astronautics is using two platforms for providing a single-plane of reference. Both of these are variations of air-supported vehicles. The larger platform, fitted with a seat, consists of a square base supported on three flat circular disks, through which air is blown, via a hose, at some 80 psi. to form an air bearing. There also are a pair of shoes utilizing the same support principle, permitting independent foot movement.



PLENCH (left) is a rachet socket wrench utilizing squeeze principles to reduce torque. Screwdriver (right) is designed to operate in zero-g conditions.

SHOES, fitted with disks through which compressed air is blown, provide one plane of a frictionless environment in which space repairman will have to operate hand tools.



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NASA Receives Signal Reflected From Venus

Radio signals reflected from Venus have been received at National Aeronautics and Space Administration's Goldstone Tracking Station, Calif. in the initial stage of a two-month experiment.

NASA reports the signal took 6.5 min. to make the 70 million mi. round trip Mar. 10, and it was the first signal to be bounced off Venus and received in a form immediately detectable with elaborate analysis and processing.

The experiment is being conducted during the two-month period centered on Apr. 11, when Venus and the earth are about 26.2 million mi. apart—the closest approach in the 19 month cycle. The project is being conducted to determine whether Venus spins on its axis and determine its rotation speed, find the orientation of the planet's spin axis, investigate the nature of the planet's surface by studying its reflectivity and derive a more precise measure of the astronomical unit.

NASA's Jet Propulsion Laboratory is using two 85-ft. antennas at Goldstone, with the transmitting antenna located 7 mi. from the receiving dish to avoid interference.

On Mar. 10, Jet Propulsion Laboratory sent a 2,388-mc.-per-second signal using about 10 kilowatts of power. The receiver used both a maser and a parametric amplifier.

Four-Stage Rocket

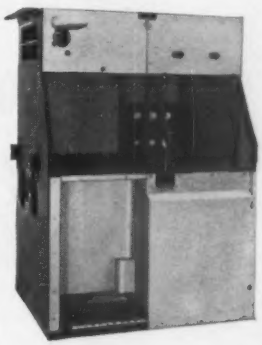
Thiokol model of proposed 4-stage rocket for manned space flight uses cluster of seven 3 million lb. thrust solid propellant motors for bottom stage, cluster of three for second stage and liquid engines for upper stages. Vehicle is part of recommendation made to NASA.

Martin's Apollo Study Has 30 Subcontractors

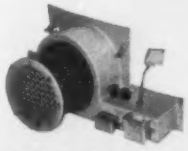
Washington—Martin Co. is being assisted by 30 firms in design studies for Project Apollo in vehicle propulsion, guidance, recovery, tracking and environmental control.

Martin, General Electric and Convair are conducting individual feasibility studies of the National Aeronautics and Space Administration's three-man spacecraft, and Martin said more than 300 companies volunteered their services "free of obligation" to take part in the study.

Radar Console



A REPUTATION BUILT ON RELIABILITY



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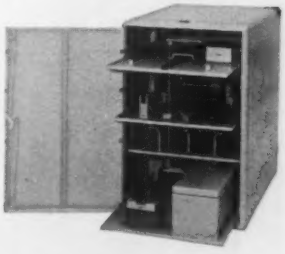

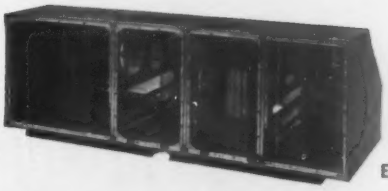

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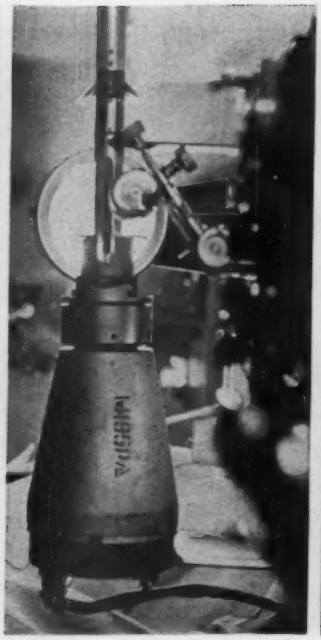
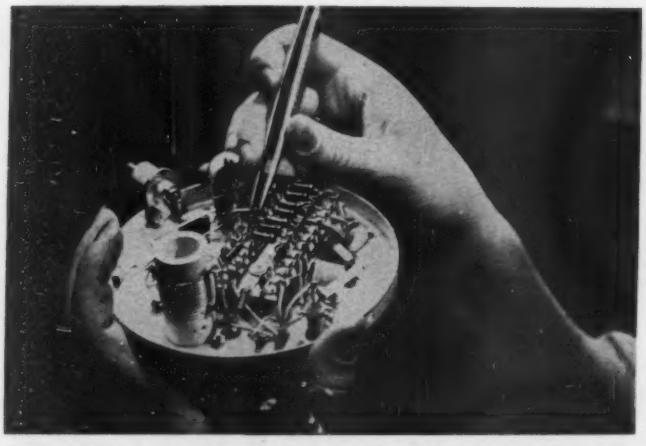
Aerobee Package Checked Out in B-57 Air-Drop

Lewis Research Center engineer (above) inspects airplane package used for development of the Aerobee recovery system. Package was air-dropped from a Martin B-57 at El Centro, Calif. At right, liquid hydrogen Dewar is checked out (AW Jan. 16, p. 28) on electric shaker. Zero-g testing was accomplished several weeks prior to Feb. 5, launch which failed to return package but was considered partially successful because of receipt of telemetered data from the rocket. Instrumented sphere, component of the 250-lb. payload, (below, left) is designed for study of liquid hydrogen in space under zero-gravity conditions. Camera canister and flotation bag of Aerobee recovery package are shown bottom right. Information gathered from Aerobee telemetry data will be used with Centaur second stage and Saturn upper stage developments.



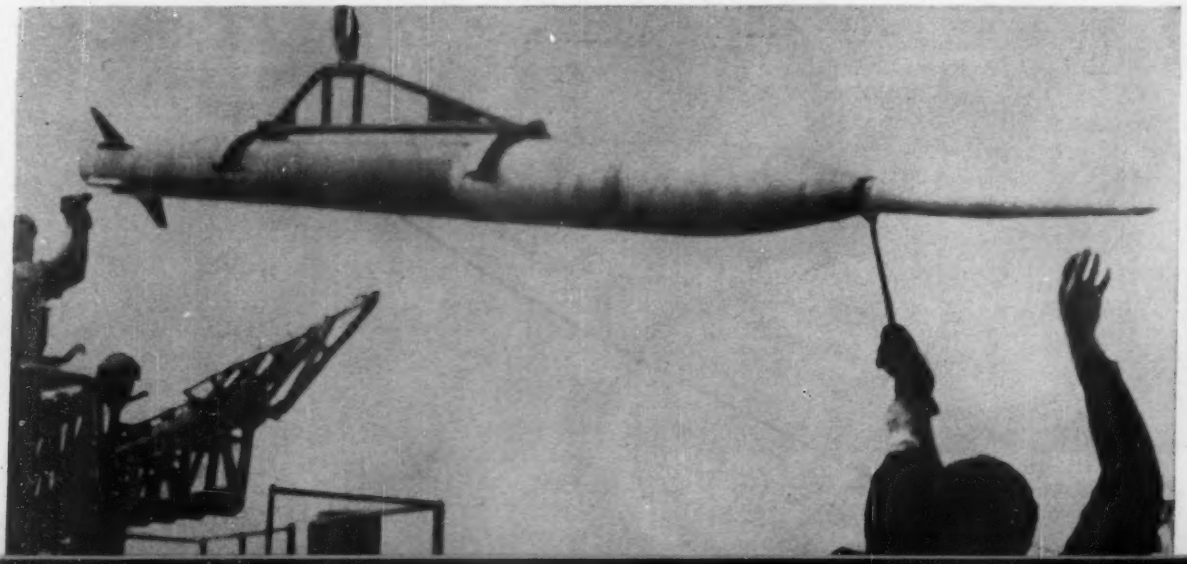
Thirteen meteorological rockets are lined up (left) after checkout, ready for delivery. Calibration of the bolometer (center) is performed with an electric arc light. Checkout of the assembled meteorological rocket head is made before delivery to observatories and bases for firing (right). Here chief engineer V. Kozlov of Moscow's Central Aerological Observatory performs the checkout.

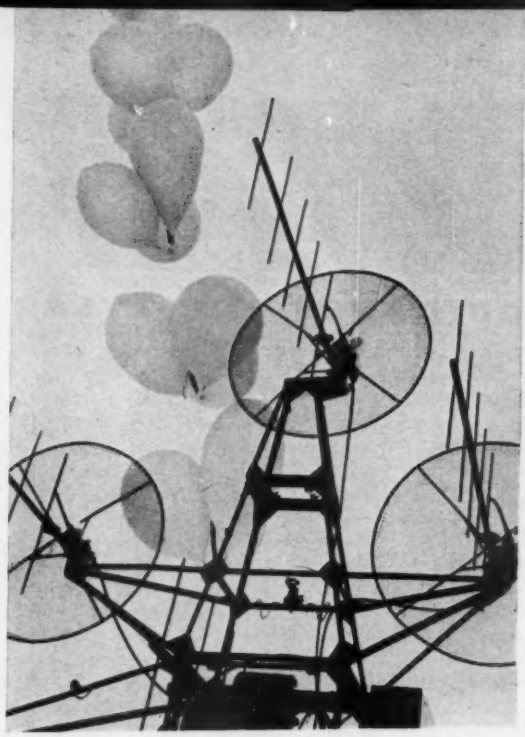


Soviet Meteorologists Strive

Russian meteorological network, operating on a wide basis within the USSR land mass and out to Arctic and other strategic waters, bases a large amount of its theoretical work on upper-atmosphere soundings with rockets. One standard instrumentation installation—a nose boom for a small rocket —is detailed in these new pictures from Soviet sources. Externally similar to the boom shown earlier by the Russians at the Brussels World's Fair (AW Apr. 28, 1958, p. 30), this unit features wire resistance thermometers strung between two spiked collars on the probe, and a bolometer, mounted in a slotted section, for measuring solar radiation. Russian meteorologists have succeeded in clearing fog from airports as part of an over-all program of weather control, say official Soviet sources. Fog-clearance and cloud-removal by forcing rain to fall are two specific results claimed

Portion of the rocket transmitter, mounted in the base of the nose cone (above), shows no use of miniaturized components, sophisticated production or assembly techniques. Rocket carrier is recoverable when firings are over land. Sounding rocket is swung into place for launching on board Russian ship (bottom photo). Note truss-work launcher with one side of framework open to receive rocket.



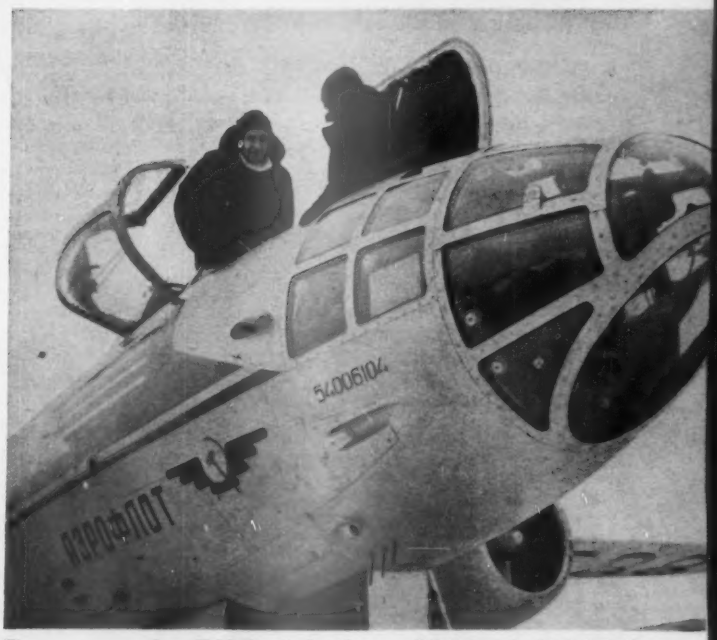


Triple array of telemetry antennas is used by Central Aerological Observatory to track upper-altitude flights presumably made by standard sounding rockets or balloons.

Manned free balloons are used by the Russians for what they term "substratospheric" flights. Shown here is pilot I. Shagin, of Moscow's Central Aerological Observatory, in simple flying suit and oxygen system.

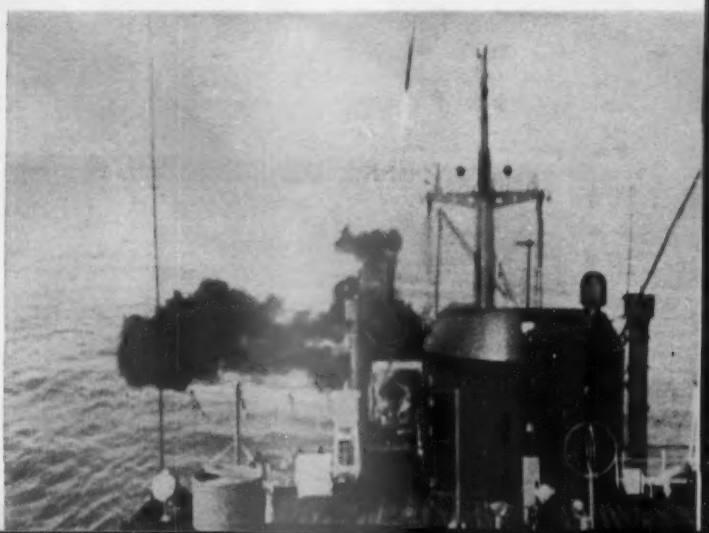
for Wider Weather Control

to have their origins in a country-wide program of simultaneous meteorological observations four times per day. Airplanes, sounding rockets, manned and unmanned balloons are used by Russian scientists in a weather network aimed at better local forecasting in conjunction with broad coverage of the entire country. Data gathered is sent to the Central Aerological Laboratory of the Central Headquarters of the Hydrometeorological Service of the USSR in Moscow for study of the theoretical processes in the atmosphere. The sources cite no further details or proofs of the claims.



Two-man crew of an Il-28 Beagle bomber, modified to take high-altitude weather data, wear flying jackets and soft helmets. Markings on plane identify the operator as Aeroflot. Meteorological flights are one part of that airline's mission. Sounding rocket (below) roars off a short tower launcher on the starboard side of this Russian research ship.

Pressure-chamber test subject is Russian engineer A. Kuleshov, shown here checking his pressure suit under the direction of Dr. N. Pisarenko of the Central Aerological Observatory. Kuleshov's suit hints at high-altitude use in stratospheric balloon gondolas, a possibility reinforced by the Russian use of "aeronaut"—the old term for a free-balloonist—to describe another technician similarly dressed.



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Soviet Space Rise Keyed to Management

Los Angeles—Russian successes in space exploration have not been achieved by fundamentally new administrative and operating methods, Leon Trilling, associate professor of aeronautics and astronautics at Massachusetts Institute of Technology, told an audience of industry technologists at a symposium here.

Trilling (AW Aug. 20, 1956, p. 50) listed five operational principles on which Soviet administration of research and development are based, and some industry officials attending the Institute of Aeronautical Sciences symposium on Soviet progress in aerospace sciences were quick to argue that these principles would be desirable in U. S. research and development programs.

The five principles cited by Trilling are:

• "**Strict priorities** insure the allocation of resources first to those tasks which party and national leadership deem most important. Policy-makers are technically literate and alert to the potential of applied science. The scientific community offers advice only on how things can be done, never on which things should be done. Like ballet dancers and piano virtuosos, they are valuable, well-kept tools rather than decision-makers.

• "**Research, development** and production are rather completely separated in Soviet industry. Scientists are generally trained at universities, research engineers and designers at leading engineering institutes, and engineers at the remaining engineering institutes. This peaking order was originally the result of the need to concentrate scarce teaching and design talent in central locations Having been set, it tends to perpetuate itself.

• "**Soviets strictly abide** by the principle of single responsibility. This is a heritage of the discipline of underground revolutionary groups and of the industrialization drive in the 1930s, when factory managers could seldom hold their jobs for more than three years before being deposed. It is less intense now but it is still a method of selecting the ablest managers and putting them to work on priority jobs.

• "**Soviets rely** on special task forces comparable to the U. S. Manhattan project to carry out specific jobs. This method is the corollary of the principle of single responsibility. The man assigned to a task puts together a team to help him. Since research and development are treated as an instrument of national policy, its objectives are specific and concrete.

• "**Characteristic feature** of Soviet research and development administration is the "multiple-hat" system which assigns concurrent administrative responsibilities to each leading scientist and so concentrates the management of large segments of the total effort in small, tightly-knit groups. This approach has been used occasionally in the United States, as when Adm. Hyman Rickover held positions in the Atomic Energy Commission and the Navy simultaneously to develop the nuclear submarine."

Trilling pointed out that figures for the year 1959 show that Russia invested 3.5% of its gross national product in research and development compared with 2.9% for the United States. He said the difference cannot be proved to be significant because of the variety of ruble-dollar exchange rates in use and the fact that all the rates vary according to the commodity being discussed. He said the similarity of the figures shows that the nature of a modern industrial society sets the economic patterns in the cold war regardless of social system.

Discussing informal methods of decision-making and communication in Soviet air research, Trilling noted that the august Academy of Sciences of the USSR "includes in its membership not only scholars, but also engineers and military officers with technical background. It is interesting that the role and number of the latter has increased markedly in the last 10 years. There are now 20 technical officers of flag or general rank among the 31 academicians in the Department of Technical Sciences. This reflects the fact that the Academy is responsible for setting national goals and coordinating all research and development activity as well as for performing research in its own laboratories. Altogether, it directly controls 12% of the research and development budget.

Soviet Academy

The Zhukovskii Military Air Engineering Academy plays a triple role. It trains officers for the technical branch of the Soviet air force, prepares promising field officers for high command and militarizes the viewpoint of designers. "The 10 ranking generals of the Soviet air force, at the present time, took a two-year course at the Academy when they held the rank of major or colonel and were of age 33-37. Most top Soviet designers including Yakovlev, Mikoyan, Gurevich and Ilyushin are graduates of it. The Zhukovskii Air Academy school-badge, therefore, singles out and unites the entire policy-making community of the Soviet air development program."

Regarding the distribution of Soviet effort, Trilling said, "they stress basic and applied research, design small numbers of prototypes, but require very large operating forces. The relative youth and initial under-development of their industrial society forced this pattern upon them as most likely to optimize the performance of some key hardware with little consideration of production cost. This Soviet concentration of effort on a somewhat higher plane of abstraction than the U. S. concentration of effort is made easier by the lack of competition in the design of hardware. Since the new practical knowledge produced by applied research is the stuff from which new products are made, insistence on applied research is another facet of the Soviet policy of priority on producer goods.

As the skill level of the working force and the sophistication of their tooling increase, the Soviets may be expected to strike out on their own more often to find new solutions for old engineering problems.

Trilling said that the Russian scientific work which is best known in this country is theoretical in nature because the Soviets are less willing to publish experimental results. Theoretical studies also seem to be the area in which Soviet scientists are most able. There has been some evidence of fundamental errors in their experimental projects. Soviet scholars have a long and distinguished tradition in the application of mathematical techniques. Trilling emphasized that "the hardware already displayed should dispel the notion that Russians do not have the gift to make things work."

F. J. Krieger of Rand Corp. delivered a resume of Soviet space experiments and astronautics at the symposium.

Krieger listed three explanations for the loss of radio contact with the Soviet Venus probe on Feb. 27 that have appeared in Russian publications:

• "**Charged particles** emitted by the sun might act as an impenetrable screen between the earth and the probe.

• "**Signals from the probe** might have been too weak to penetrate to the earth.

• "**Meteors might have caused** some damage to the interplanetary stations."

Krieger pointed out that communications and telemetry with their space vehicles appears to be the weak point in the Soviet program. Failure of communications or the loss of a telemetry signal has terminated more tests than vehicle failure.

Krieger said "the accuracy of the Soviet guidance system is evident at each step of the program, particularly

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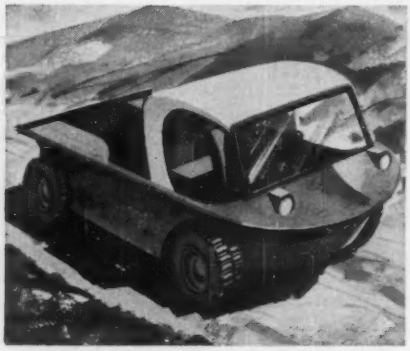

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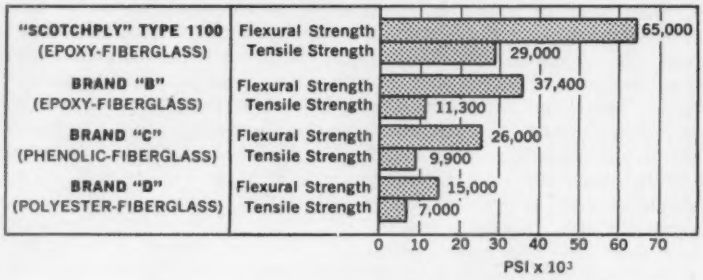

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in connection with the recovery of Sputniks V, IX and X canine capsules and the launching of the Sputnik VIII Venus probe. The feat of landing a capsule allegedly within 10 km. of a predetermined point shows not only a high degree of technical skill but also considerable confidence. The Soviets ostensibly have sufficient thrust to boost aloft an inertial guidance system, whatever its mass, which permits them to guide their satellite precisely into the predetermined orbit. Knowing the elements of this orbit, they can predict the satellite's position at any moment, kick it out of orbit with a retrorocket, and land it with great accuracy, using vehicle aerodynamics and recovery parachutes in sequence.

"The Soviets have also demonstrated a more subtle ability. This is their apparent superiority in complex automatic control systems. The tendency to over-engineer a system and the consequent increase in its unreliability have plagued and embarrassed U. S. rocket experts again and again. The Soviets, on the other hand, by stressing fundamental principles and simplicity in design, have apparently developed the faculty for making proper executive decisions in the manufacture and use of computer-based control systems and determining which of several automatic control concepts is the best. It is safe to say that they are transforming this superior flexibility and capability in rocket technology into a correspondingly greater lead in the exploration of outer space and its many implications."

Systematic Schedule

Krieger noted that the systematic plan of Soviet space exploration outlined in part by Prof. G. V. Petrovich in March, 1959, is essentially the same as that suggested by K. E. Tsiolkovsky at the turn of the century. The plan consists of three phases to be pursued simultaneously.

The first phase would have the primary purpose of establishing earth satellites in near-polar orbits to put the entire earth under constant surveillance. The second is the exploration of the moon. This program has been progressing on schedule.

In manned exploration of the moon, the Soviets propose to send two rockets as a precautionary measure and to ensure success.

The crews could be of mutual assistance to each other in exploring the surface of the moon and in preparing for the return trip. In an emergency the two crews could return together in one rocket.

The third phase of the Russian space exploration program is the investigation of the planets and was opened by the recent Venus probe and the earlier artificial satellites of the sun.

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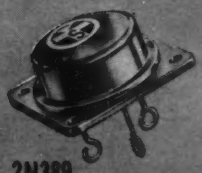

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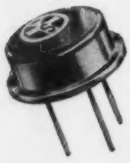

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Missile Defense Dominates PMR Efforts

By Russell Hawkes

Kwajalein—Programs to develop a workable defense against ballistic missiles and boost-glide vehicles are rapidly coming to dominate all other efforts in the Pacific Missile Range and the focal point of these efforts is Kwajalein Atoll, 4,300 mi. west of Pacific Missile Range headquarters at Pt. Mugu, Calif.

Two key programs are the development of the Western Electric-Douglas Nike Zeus anti-ICBM by Army Rocket and Guided Missile Agency and Project PRESS (Pacific Range Electromagnetic Signature Studies) to be conducted by the Lincoln Laboratory of Massachusetts for Advanced Research Projects Agency.

The two programs are very closely related because Project PRESS was instituted to find the means of distinguishing between real and decoy warheads and may provide great benefits in the design of the discrimination radar which is the least advanced part of the Zeus system.

Midas System

Another major ballistic missile defense program on the range is Midas (Missile Defense Alarm System), part of USAF's continuing WS-117L series, which also includes Samos and Discoverer satellite systems. Most of the effort in the USAF program is concentrated farther up-range in Hawaii and on the mainland.

Other important programs using Pacific Missile Range or scheduled to use it include:

- **Caleb** air-launched satellite.
- **Dyna-Soar** orbital glider.
- **Phoenix** economical large booster program.
- **Tepee** missile detection system.
- **Minuteman** ICBM.
- **Transit** navigation satellite tracking and telemetry.
- **Mercury** manned orbital flight tracking, telemetry and contingency recovery.
- **Tiros** weather satellite telemetry readout.
- **Automatic tactical data system,** an airborne anti-submarine warfare combat information center to be used in the Lockheed P3V.
- **Pershing** selective combat range artillery missile.
- **Sergeant** mobile artillery missile.
- **Hydra** water-launched space vehicle booster study.
- **Space experiments** using Scout low-cost booster system.
- **Ballistic missile crew training launches** for Strategic Air Command.
- **Electronic countermeasure** surveillance missile study.

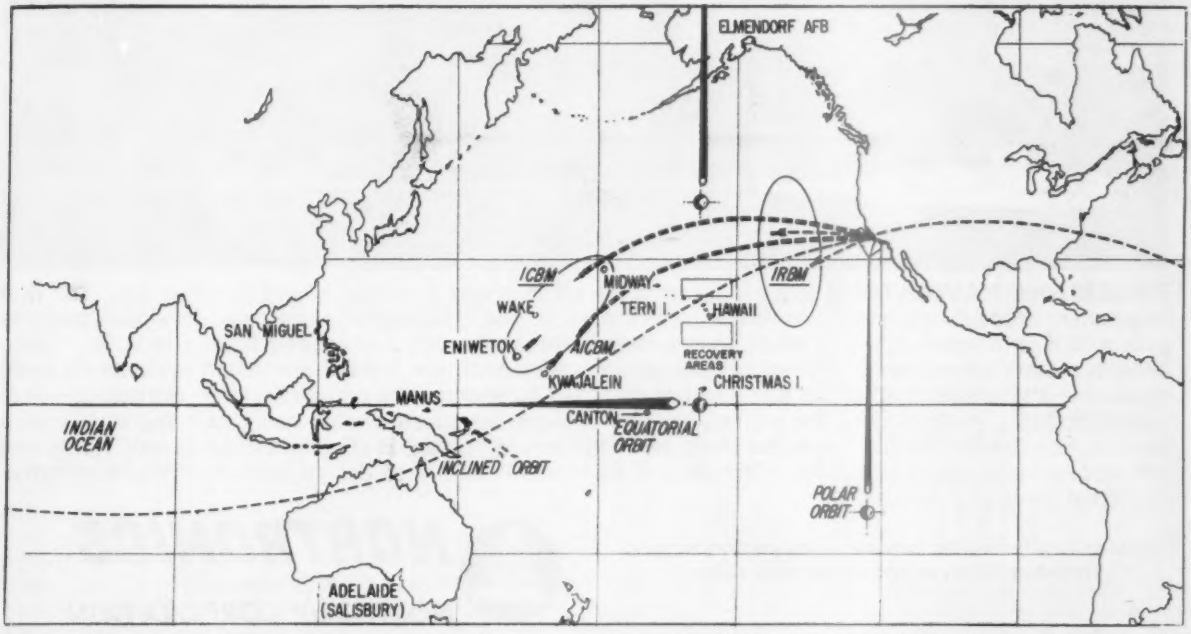
Since the Russians have begun launching missiles into the Pacific Ocean, Pacific Missile Range operations have taken on an aspect not present at Atlantic Missile Range and White Sands Missile Range, N. M. The Russian firings have increased the significance of the anti-ICBM facilities downrange and have increased the ambiguity of the already ambiguous chain of command that characterizes the three national missile ranges. Radars and missile impact locator systems operated by Pacific Missile Range, and equipment assigned to specific projects, funnel information on Russian firings through the military chain of command for operational purposes as well as through the management hierarchy for system development purposes.

Russian Factor

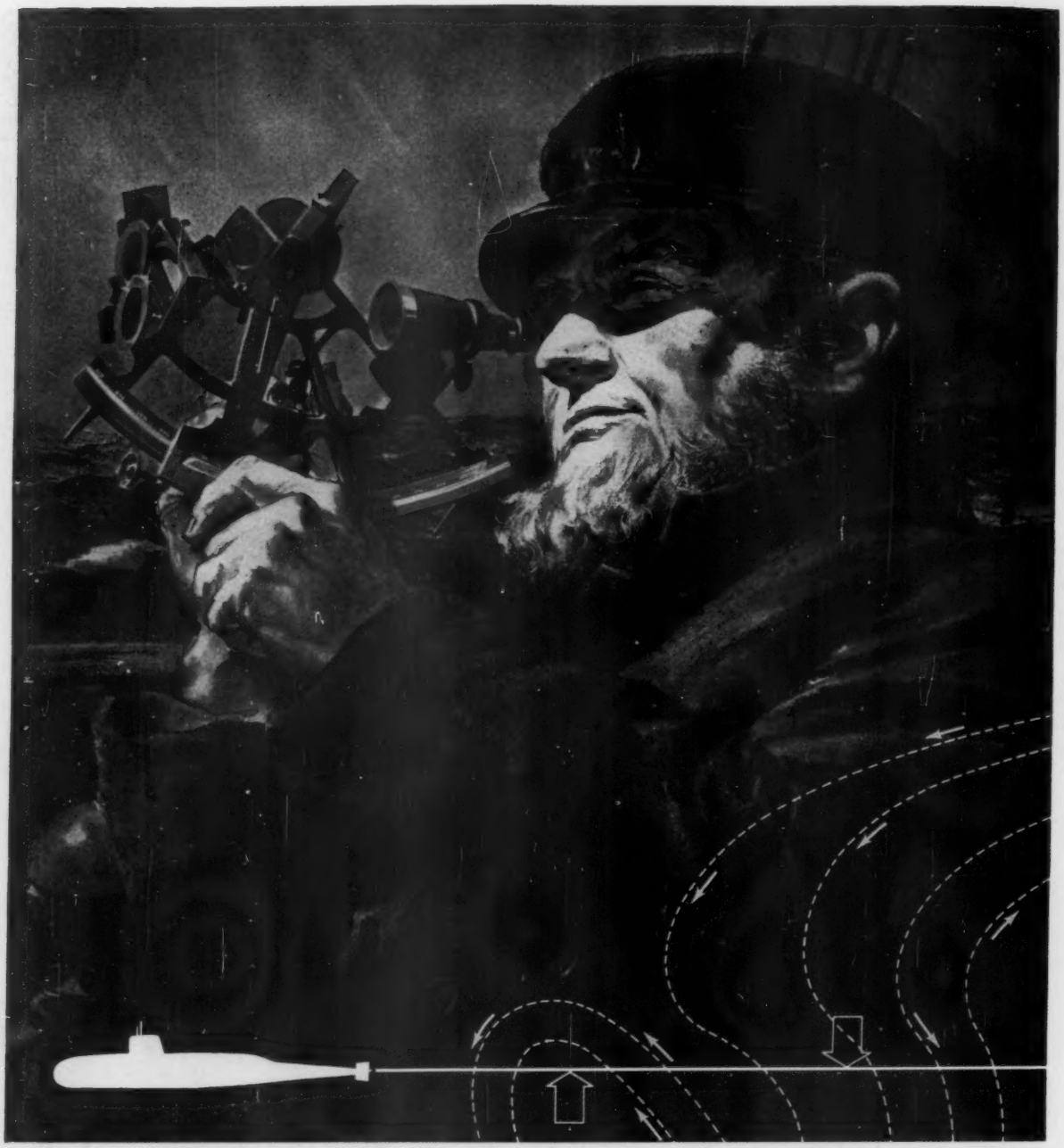
To save money, the Zeus acquisition radar on Kwajalein will be only partially completed to look northeast toward target missiles coming from the United States. However, an engineer on the project assured AVIATION WEEK that the Kwajalein Zeus acquisition radar would be able to look northwest with enough efficiency to detect incoming Russian missiles.

More significant is the fact that the 84-ft. dish-type TRADEX antenna in Project PRESS on Roi-Namur will be able to look toward the Russian warheads almost as easily as it does toward U. S. ones, though a dead zone affecting low-elevation radar returns lies to the west and extends slightly into the northwest quadrant. The opportunity to develop methods of identifying Russian warheads by studying actual Russian warheads is obviously too good to miss.

Flexibility and mobility are prime



FOUR of the five ranges that make up the Pacific Missile Range are shown—the IRBM, ICBM, anti-ICBM and polar orbit ranges. Also shown is equatorial orbit range on Manus Island which PMR wants to establish. Not shown is Sea Test Range near California.



PRECISION NAVIGATION today is far from the art as it was practiced even 100 years ago. The first charts were crude diagrams with no reference to the earth. The first magnetic compass, developed perhaps over a thousand years ago, was made from a needle thrust through a straw and floated in water. These ancient methods have since evolved to celestial navigation and now inertial navigation systems that can determine a ship's position within a few feet of its actual location on the earth's surface. Nortronics — Precision Products, in developing the primary sensors in these advanced inertial navigation and stabilization devices, has contributed not only to the basic art but to setting standards of performance as well. Nortronics has unique career opportunities for scientists and engineers in advanced design, production and application of inertial gyros and devices.

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requisites in Pacific Missile Range installations, according to Rear Adm. Jack P. Monroe, Pacific Missile Range commander. The operating philosophy of the range is to use instrumented ships, aircraft and minimum cost installations on the many islands of the Pacific Ocean. This practice enables instrumentation to be shifted quickly from one program to another and new programs can be accepted on short notice and conducted with minimum costs.

Massive deep space probe telemetry receivers and other equipment requiring exceptional accuracy or very large size must be permanently installed. Whenever possible, however, the range makes a practice of using van-mounted equipment. Thus, when the cancellation of the Regulus II program closed the Chance Vought-operated PMR Inland Range to Dugway, Utah, the range instrumentation was moved to Hawaii to support other programs. Much of it is now located at the Kokee Park and Barking Sands facilities on the island of Kauai where it will be used in National Aeronautics and Space Administration's Project Mercury launches.

Instrumentation vans have even been placed aboard tracking and telemetry ships in preference to more conventional shipboard instrumentation installations. Adm. Monroe reports that the performance of these installations has been satisfactory and the economies have been considerable.

PMR Subdivisions

Range officers say Pacific Missile Range is actually five ranges:

- **Sea Test Range** is a strip of water off the central California coast which is used to test relatively small underwater, surface-to-air and air-to-air missiles.
- **Intermediate range ballistic missile** range extends from Vandenberg AFB, Calif., to an impact area midway between the West Coast and Hawaii. Little downrange instrumentation is used aside from the missile impact locator systems stations and shipboard impact locator stations. Vandenberg is an independent user of the range and not a Pacific Missile Range facility.
- **Intercontinental ballistic missile** range extends from Vandenberg and Naval Missile Facility, Pt. Arguello, to impact areas in the Marshall Islands.
- **Anti-ICBM range** consists of the facilities and fallout areas of the Zeus and PRESS projects on Kwajalein Atoll.
- **Polar orbit range** is a line straight south from Vandenberg and Arguello. Such instrumentation as is needed in the launch phase can be land-based no farther south than San Nicolas Island. Beyond that, Pacific Missile Range must depend on shipboard instrumentation. With the completion of three ship conversions now under way, Pacific Missile Range will have seven instrumentation and re-entry capsule recovery ships. The range can occasionally enlist the aid of fleet units.

Land installations under the command of Pacific Missile Range are:

- **Kwajalein Atoll,** Marshall Islands.
- **Naval Missile and Astronautics Center,** Point Mugu, Calif.
- **Naval Missile Facility,** Pt. Arguello, Calif.
- **San Nicolas Island,** Calif.
- **Small coastal stations** at Point Sur, Point Pillar, San Clemente Island, Anacapa Island, Santa Cruz Island, Santa Rosa Island and San Miguel Island.
- **Pacific Missile Range** communications and missile impact locator systems net center at Marine Corps Air Station, Kaneohe, Oahu, Hawaii.
- **Kokee Park,** Kauai, Hawaii.
- **Barking Sands,** Kauai, Hawaii.
- **South Point,** Hawaii.
- **Tern Island,** Hawaii.
- **Eniwetok Atoll,** Marshall Islands.
- **Wake Island.**
- **Midway Island.**
- **Canton Island.**

Pt. Mugu will be the first Pacific Missile Range station to become active in the Nike Zeus program this fall when missiles will be launched from there to test the command guidance system, the control system, and the solid propellant jet-head which acts as final stage propulsion and jet reaction control unit. However, by March, 1962, the project will have moved to Kwajalein for the climatic tests of the whole system against realistically warlike problems. The only element of the system which will not be ready for the first tests will be the discrimination radar which is supposed to distinguish between decoys and real warheads.

Total Development Cost

Counting the expected Fiscal 1962 funding, the total development cost for the Nike Zeus system would have exceeded a billion dollars. Counting only present funding, it has reached $750 million. Of this, $75 million will have been spent upon the Kwajalein base. Construction work on the base is already 80% complete and the installation and checkout of some of the technical components of the system has begun.

Meanwhile, components of the system are being tested at three other locations. Prototypes of the Zeus acquisition radar, missile track radar, target track radar and target intercept computer have been undergoing tests at White Sands Missile Range since last July. The first two stages of the

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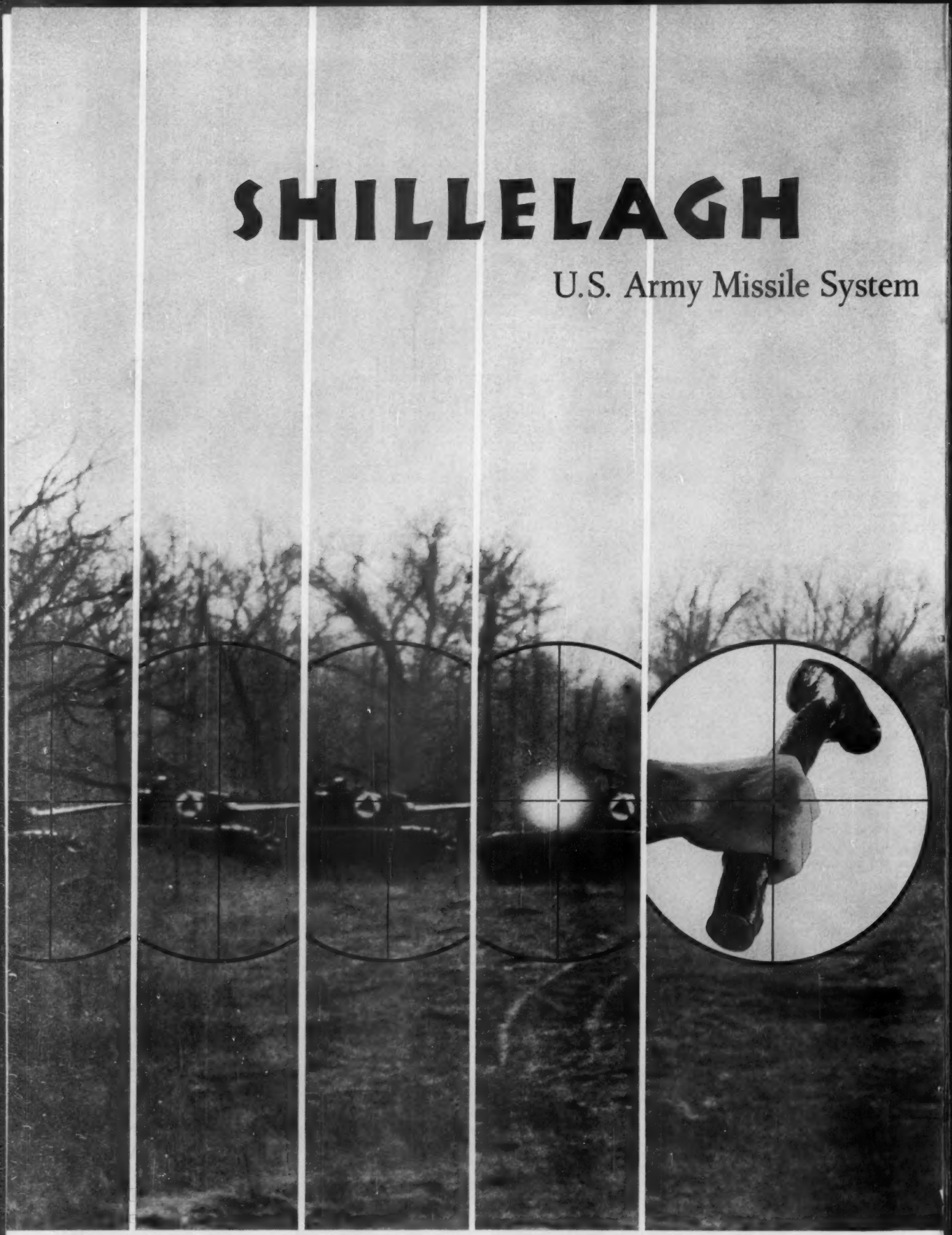

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missile have been fired there in propulsion tests since August, 1959. The limited size of the White Sands range prohibits the three-stage tests planned at Pt. Mugu. A target track radar has been installed at Ascension Island in the Atlantic Missile Range and is tracking missiles from Cape Canaveral to get data which will be the basis of any final modifications of the target track radar to be installed at Kwajalein.

The climax of the system test phase is to be the launch of Zeus missiles from silo-type launch cells on the western tip of Kwajalein Island at the southern end of Kwajalein Atoll against USAF-Convair Atlas ICBMs The launch cells are being built above ground to conserve money but operational cells would be underground. Army has purchased 18 Atlases which will be launched toward the Marshall Islands from Vandenberg AFB by USAF crews.

Realistic Testing

To make the test as realistic as possible, USAF has been instructed by Defense Department to use every decoy and electronic countermeasure it can devise in time for the tests. Zeus team members are to receive no warning of the launch times and targets assigned to the Atlas missiles. The Zeus system must detect and intercept automatically. Army personnel are beginning to think of the tests as showdown contests between the two missile systems. Pacific Missile Range officials say that no more realistic tests could be staged short of actual war. In the Zeus-Atlas contests, the Pacific Missile Range staff will have to carry out its responsibilities for scheduling, frequency interference control and range safety without alerting the Zeus staff at Kwajalein.

Range Safety

The range safety problems posed by the Nike Zeus system tests appear to be the most severe yet encountered in missile technology. Three circumstances make the safety problem complex:

- **Incoming Atlas missiles** must be targeted to land somewhere in the general vicinity of the inhabited Marshall Islands.
- **Two long-range,** high-speed missiles will be in the area at once.
- **Community of Marshallese** natives is located only three miles to the north of the Zeus launch cells on the island of Ebeye.
- **Unprecedented acceleration** of the Zeus missile combined with a fully automatic in-silo launch will make it much more difficult to see the condition of the missile, achieve an impact prediction and act upon it before a hazard is fully developed. The 22,000-lb. initial weight of Zeus and the 450,-000-lb. thrust of its booster gives the missile an initial thrust-to-weight ratio of more than 20 and an initial acceleration of slightly less than 20g. The acceleration will rise rapidly to even higher values as propellant burns out of the booster motor. By comparison, the initial acceleration for liquid propellant ballistic missiles is typically about 0.4g.

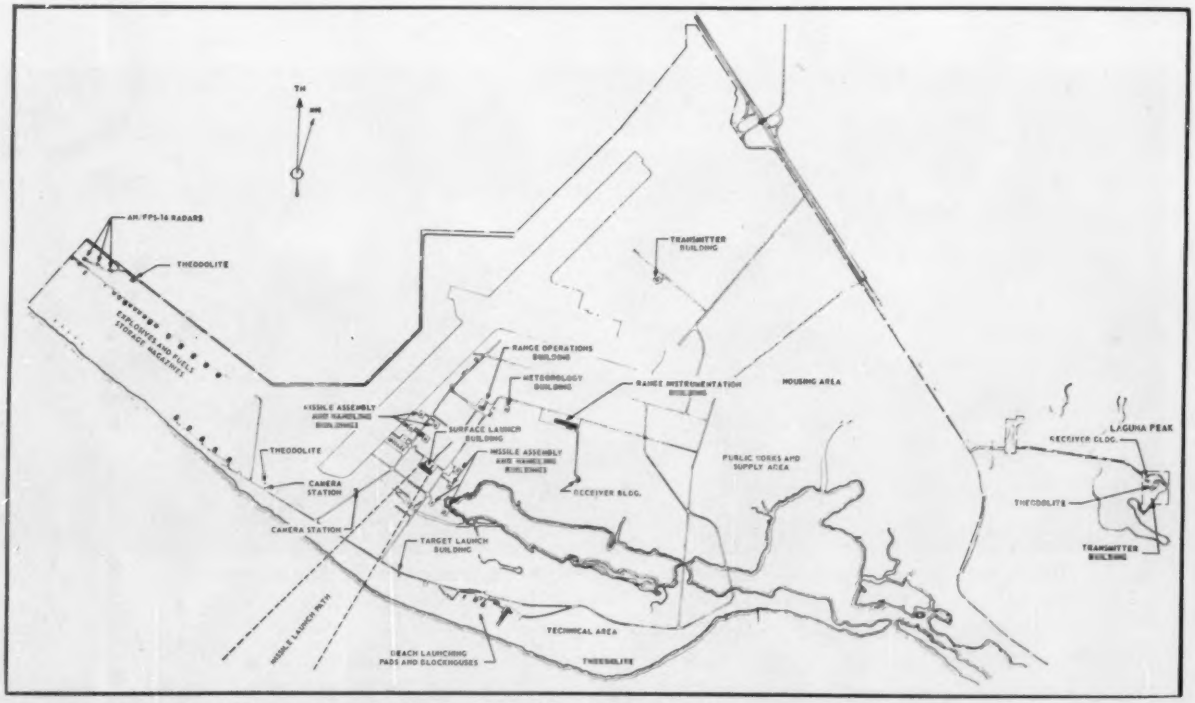
The fast acceleration of the missile has necessitated that the launch cells be designed with a five-degree cant to the south so the missile or its fragments will not fall back into the launch area if a catastrophe occurs immediately after lift-off.

Because the Atlas will be coming from the northeast, the southward cant of the launch cell gives the Zeus an over-the-shoulder trajectory which will take it clear of Ebeye. Atlas has range to spare for the Zeus target mission, so the intercept point can be offset far enough to improve that clearance.

Target Hazards

Any hazard created by the Atlas target can be handled from the California end of the trajectory without adding to the burden of the safety officer downrange. The ability to predict Atlas impact points with good accuracy is well established. Miss-distance indicators in the two missiles will determine whether Atlas or Zeus wins the contest.

Preliminary Zeus system tests will see the anti-ICBM launched against three-stage, solid propellant Speedball target rockets launched from Roi-Namur Island at the opposite end of Kwajalein Atoll. Speedball is an off-the-shelf system. It reaches a maximum velocity of about 8,000 fps. and is capable of an altitude of about 180 mi. on a flight 40 mi. down range.



MAP shows Pacific Missile Range's Naval Missile Center, Pt. Mugu, Calif., launch operations and instrumentation facilities.

A fully operational Nike Zeus system is likely to consist of a defense center serving a variable number of batteries. The defense center would be little more than the Zeus acquisition radar and its necessary computers in the Zeus acquisition radar receiver building. The acquisition radar will assign targets to the various batteries and will feed look angles to the battery target track radar (TTR) sets. On the basis of the TTR data, the target intercept computer in the battery control building will launch a missile and use the command guidance system to steer it toward its target.

The entire functioning of the system will be automatic. Army Rocket and Guided Missile Agency officers say human intervention is possible but is not encouraged. If the Zeus system reaches operational status in its present form, it will probably be the first time that nuclear warheads ever have been placed so completely at the disposal of an unmanned electronic system.

The maximum firing rate of a battery probably will be set by the number of target track radar sets assigned since a TTR is a narrow-beam radar that can handle only one target at a time. As the mission time will be short, it is probable that each TTR will be expected to handle a number of missions in succession and the number of sets assigned to each battery will be smaller than the number of missiles assigned. In the $75-million system test facility on Kwajalein, four launch cells and one target track radar are under construction and a second TTR is planned for the future.

The prime contractor for construction on Kwajalein is a joint venture known as Pacific-Martin-Zachry. At present, construction contracts total $32 million on Kwajalein Island and are expected to reach a total of $40 million. The rate of progress on construction work is indicated by a $1.25 million per month rate of contractor payments in the first 17 months after the start of work in August, 1959. On Roi-Namur the value of construction will approximate $25 million.

Acquisition Radar

The dominant visible feature on Kwajalein is the Zeus acquisition radar with its huge separate transmitter and receiver antennas which rotate synchronously.

Zeus program officials claim the acquisition radar is the most powerful radar ever built. The transmitter antenna is in the form of a horizontal triangle and is 80 ft. long on a side. In an operational battery the transmitter building would be surrounded by a curved 65-ft.-high beam-shaping fence with a radius of about 350 ft. The mesh fence would also provide some protection against the biological effects of the powerful radio frequency emissions from the antenna. Zeus program engineers calculate that the emissions from the acquisition radar transmitter could be dangerous to a distance of about 330 ft.

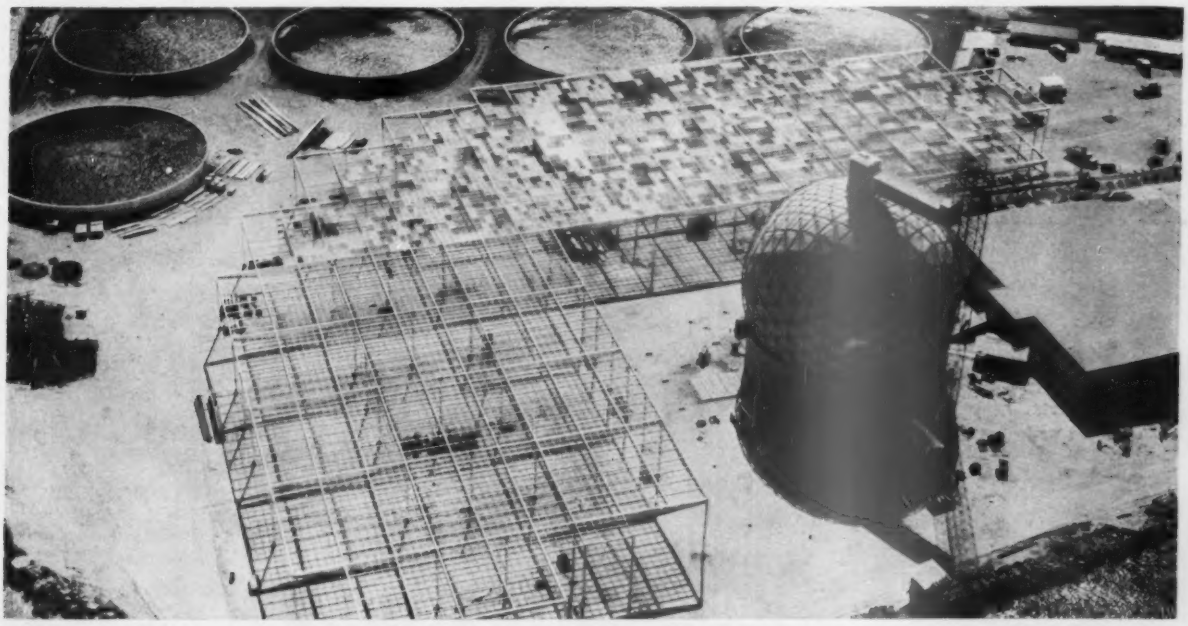
Access to the transmitter building is through a 290-ft.-long corrugated iron shielding tunnel that passes through the beam-shaping fence. The tunnel is also used as a shielded cableway in which electrical circuitry will not pick up the powerful transmitter signal. The transmitter building itself is clad with Terne metal (steel coated with a tin-lead alloy) to prevent the transmitted signal from being fed back into the transmitter circuitry. The 18 klystron tubes used in the transmitter each weigh 1,100 lb. and must be shielded in lead to prevent them from emitting X-rays inside the building.

The acquisition radar transmitter antenna drive motor is slaved to the receiver antenna and both normally rotate at 10 rpm.

The transmitter signal is emitted inward from a feed in the center of each side of the triangular antenna, reflected from a parabolic "pillbox" and passed through the 80-ft.-long polarizer-window. The polarizer-window is a laminated glass honeycomb surface with a copper polarizing grid embedded in it. It is covered with an inflatable rubberized de-icer boot for use in arctic locations.

Luneberg Lens

The Zeus acquisition radar receiver antenna is made of a rotating hemispherical Luneberg lens almost 100 ft. in diameter with three 3-ft. wide arrays or towers of horn-type receiver antennas. The three horn towers are 120 deg. apart and each consists of about 50 banks of receiver horns



LUNEBERG LENS of the Zeus acquisition radar receiver antenna is protected by a geodesic dome-shaped tent during assembly. The structure partially surrounding it is the ground plane or reflecting plane which reflects radar returns upward into the hemispherical lens. In an operational acquisition radar the ground plane would completely surround the antenna and cover the receiver building at right. The tanks in the background store trapped rain water. The only other sources of fresh water on Kwajalein are sea water distillation plants.

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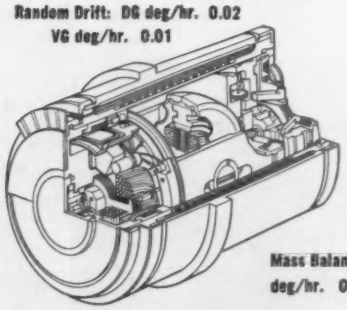

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Anisoelastic Drift: deg/hr./g² 0.01

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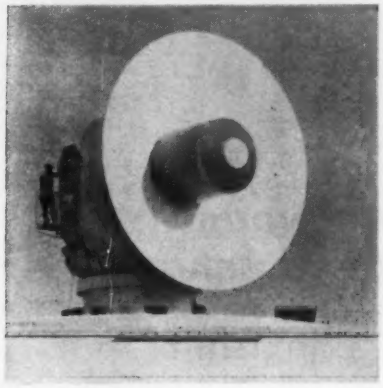
reaching up along the curved surface from the base of the hemisphere almost to its apex.

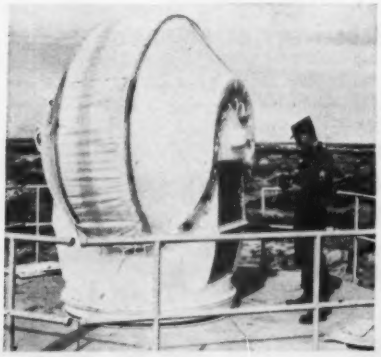
The Luneberg lens will focus the radar return upon one bank of horns. Which bank will depend on the angular elevation of the source of the return. The signal probably will be received by several horns at once with a variation of signal strength which will enable computers to give target track radar sets a quite precise look-angle.

A classic Luneberg lens is a full sphere. The Zeus acquisition radar receiver lens can be a hemisphere because the radar's targets will be above the horizon. A two-acre horizontal reflecting plane around the receiver reflects incoming radar returns upward into the hemispherical lens. The lens itself is built up of 34,484 "media blocks" of foamed plastic loaded with metal filaments to control their dielectric constant and thereby give the desired refraction of the radar frequency.

When the media blocks have been stacked into a completed lens, a nylon



PENCIL-BEAM Zeus target track radar will only be able to track one incoming warhead at a time. It will begin tracking the incoming missile at about mid-course.



NIKE ZEUS missile track radar was tested at White Sands Missile Range before being installed at Kwajalein. It needs a fast slew rate to follow the fast-accelerating Douglas-built rocket.

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weather cover will be glued over it. Photographs of a Zeus battery show a geodesic dome-shaped weather shelter, not the lens itself. The receiver building is to be located under the reflecting plane of the receiver antenna.

The receiver antenna is to have a slow-speed drive capable of rotating it at a rate of only one revolution in 10 min. as well as the high-speed drive for the operational rate of 10 rpm. The slow-speed drive will allow the crew to align the horn towers with transmitter antenna lobes very precisely in the checkout operation.

The rotating parts of the receiver antenna will weigh 2,800,000 lb. and will turn upon a 30-ft.-dia. thrust bearing consisting of 36 fixed shoes or fingers. R. W. Brown of Goodyear Aircraft Corp., contractor for the Zeus acquisition radar antenna, calls the design a hydrodynamic-hydrostatic bearing.

The Nike Zeus system will always have at least two completely separate powerplants because the battery and the antenna system need not always be the same distance apart.

The powerplant for the acquisition radar and its data processing equipment in the receiver building will consist of nine 1,500 kw. diesel electric generators weighing 80 tons each. In keeping with the redundancy incorporated throughout the Zeus system design, the powerplant will function as two systems with one on standby. The standby power supply must be capable of going on the line immediately if the operating system begins to function out of tolerance.

Cooling water is a critical problem on Kwajalein where there is no natural supply of fresh water other than trapped rain. To economize on the fresh-water supply, the acquisition radar diesel generators were designed with a two-stage heat exchanger. A relatively small amount of distilled water circulates through the cooling jackets and is recooled at a heat exchanger whose cold side is fed salt water from the Kwajalein lagoon.

The Zeus battery powerplant will consist of six 800-kw. generators and will supply the target track radars, the discrimination radar, the missile track radar and the target intercept computer in the battery control building as well as the launch cells and the missile checkout equipment.

The intense radio frequency radiation environment expected on Kwajalein Island has obliged Pacific Missile Range to move communication transmitters and receivers to other islands in Kwajalein Atoll. Transmitters are being set up on the island of Gugeegue and receivers are being put on the island of Ennylabegan. Construction costs on each island approaches $3 million including living quarters, rain water catchment areas and powerplants. There will be one Askania tracking camera site on Gugeegue and two on Ennylabegan which will also have a transformer station and a hardstand for a telemetry trailer.

Nearly all the 2,700 military, civil service, contractor and dependent personnel on Kwajalein at present live on the 602-acre island. If they work elsewhere in the atoll they must commute. Gugeegue and Ennylabegan are close enough to reach by boat, but Roi-Namur is nearly 50 mi. away. Long-distance transportation is provided in a twin-Beech operated by the Transport Co. of Texas or in a Navy Grumman UF Mallard flown by PMR Navy crews.

The big TRADEX (Tracking Radar, Experimental) of Project PRESS will be located on Roi-Namur to study incoming targets for Zeus. Roi-Namur is also a good place from which to watch incoming Russian warheads. The TRADEX is being made by Radio Corp. of America and is a dual-band radar operating in the UHF band and the L-band. It will be able to use simultaneous operation on two frequencies to work out gating techniques which will make it possible to collect rate data on re-entry bodies. Installation is scheduled to be complete in late 1961. Optical and infrared studies of incoming warheads will be made by instruments on Roi-Namur and Kwajalein Island and aboard aircraft based on Eniwetok. PRESS is a field experiment to determine what physical effects of ballistic missile flight are detectable. It is part of the broader Project Defender being conducted by the Advanced Research Projects Agency.

Army Rocket and Guided Missile Agency is procuring the TRADEX for ARPA and will conduct the technical liaison between PRESS and the Zeus program. Pacific Missile Range will take over the responsibility for logistics and housekeeping from ARGMA when RCA turns the equipment over to the operating contractors from Lincoln Laboratory in about July, 1962. Pacific Missile Range in turn will contract the responsibility to Transport Co. of Texas which is already providing these services elsewhere in the Kwajalein complex. TCT was awarded the cost-plus contract by Navy Bureau of Aeronautics.

The Naval Missile and Astronautics Center, Pt. Mugu, Calif., is used by Navy commands and contractors for the test and evaluation of guided missiles in the Sea Test Range. It is also the site of tracking and telemetry equipment operated by Lockheed Missile and Space Division in USAF's Discoverer-Midas-Samos series.

The Project Hydra water-launch concept being promoted by PMR is to be

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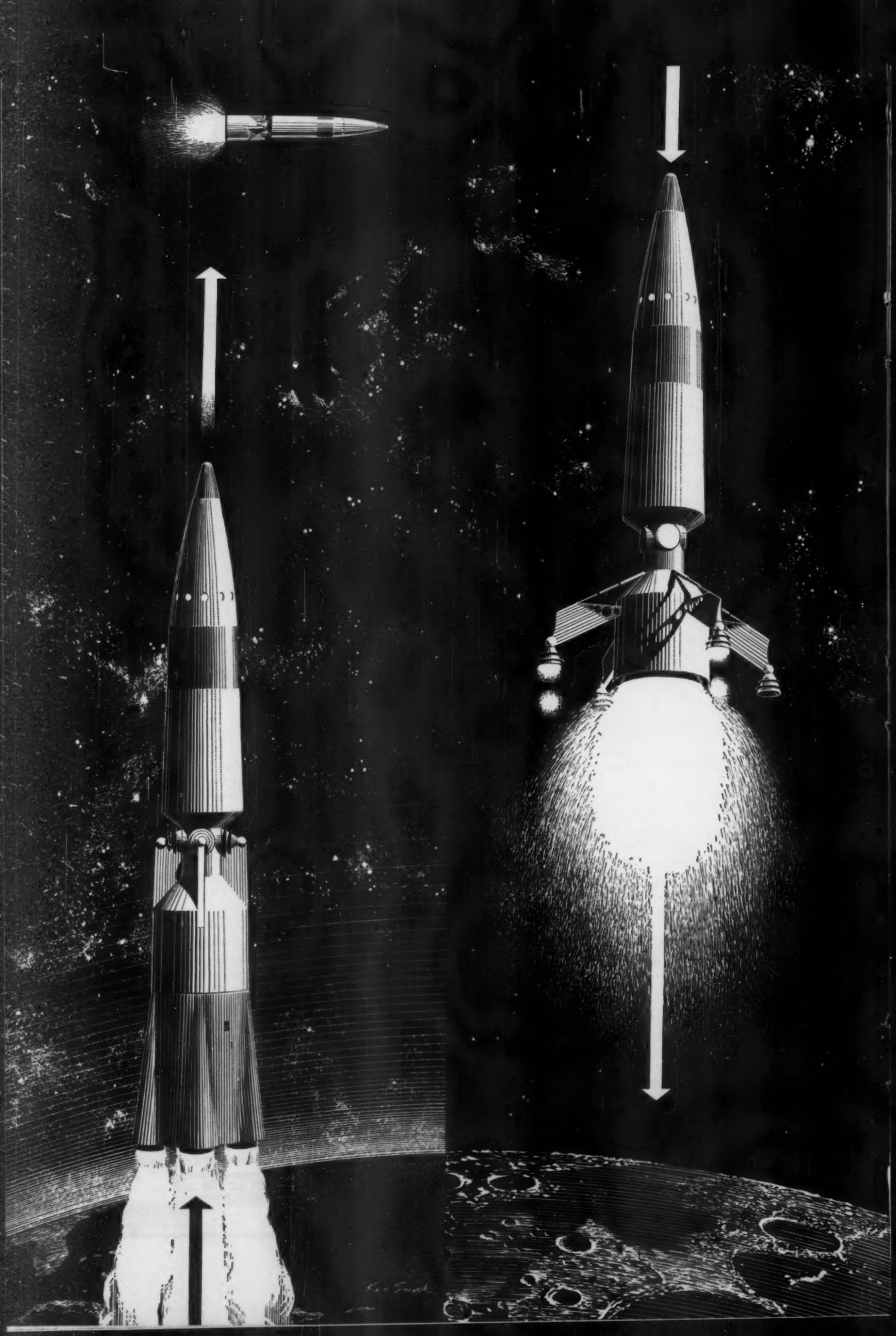

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A large rocket engine burning high-energy boron fuel and a storable oxidizer has demonstrated the highest performance ever attained with storable liquid propellants. In a static test firing the engine operated at 98% efficiency using a combustor design developed from high-energy fueled ramjets. The tests — part of a program sponsored by the Air Force — although limited to 100,000 pounds of thrust, proved an operational capability exceeding any ever attained with storable liquid propellants in large scale firings.

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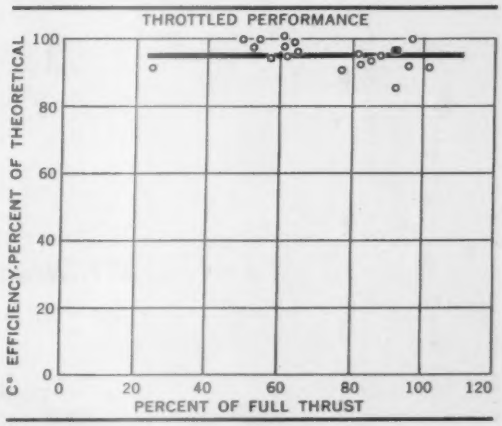
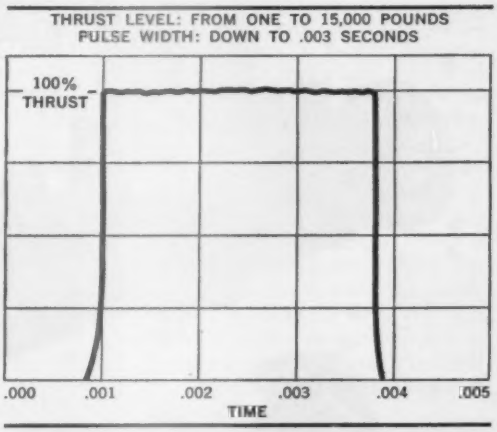
For information concerning Marquardt propulsion systems contact Don L. Walter, Vice President, Power Systems Group.

Scientists and engineers experienced in the fields of advanced propulsion devices are invited to investigate exceptional career opportunities with The Marquardt Corporation.

[1]*Energy Management — The technique of programming the use of stored chemical energy in a space system for maximum performance.*



VARIABLE THRUST ROCKET ENGINE
A typical group of rocket test firings using storable liquid propellants prove an average C* efficiency of 95% over a wide throttling range.



DOCUMENTED IMPULSE CAPABILITY
The above trace represents one impulse bit — demonstrating controllability of pulse width down to .003 seconds.

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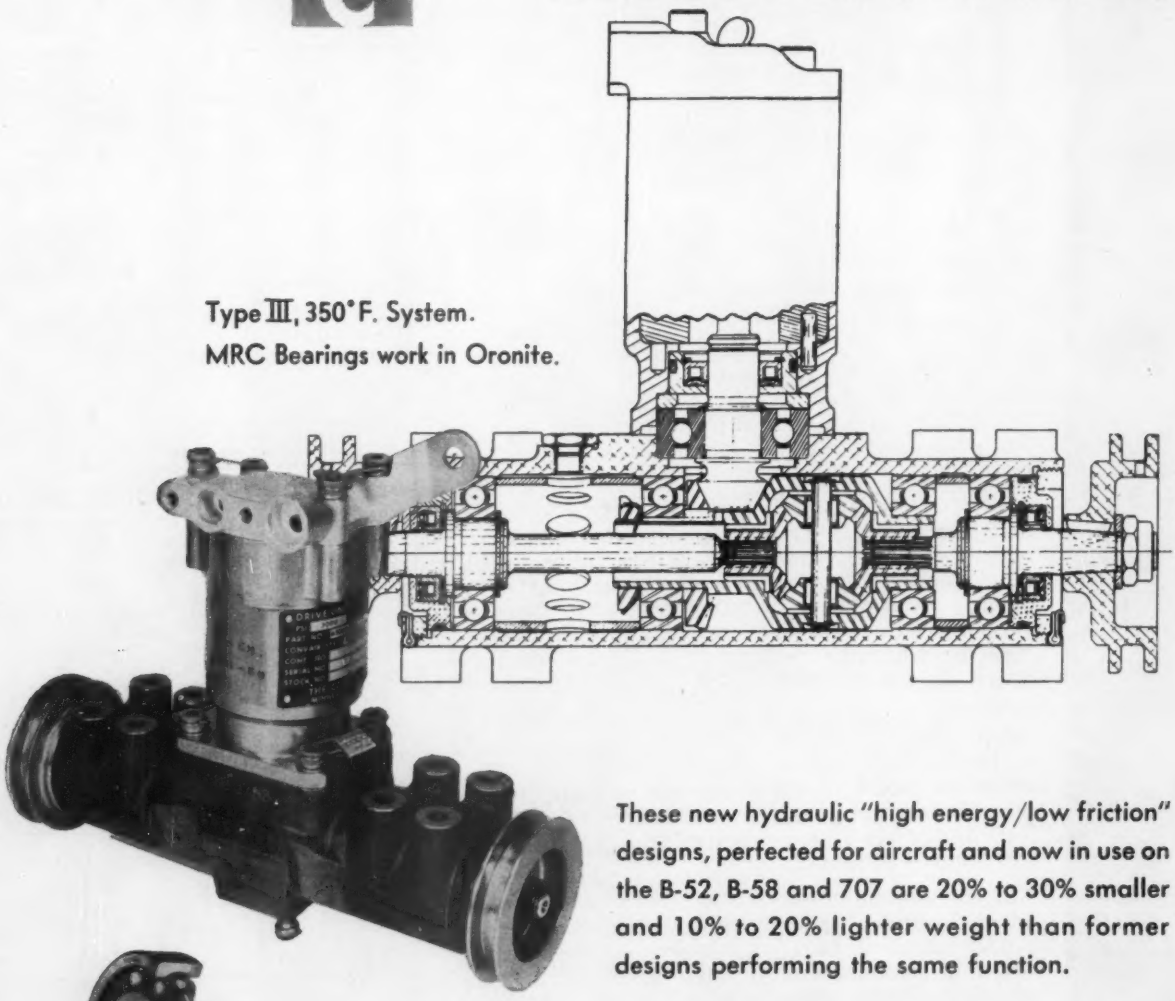
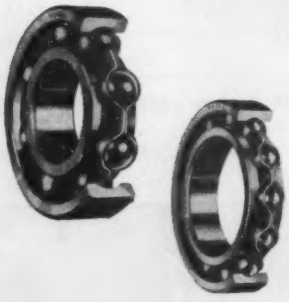


These new hydraulic "high energy/low friction" designs, perfected for aircraft and now in use on the B-52, B-58 and 707 are 20% to 30% smaller and 10% to 20% lighter weight than former designs performing the same function.



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studied at Pt. Mugu in an open-water launch of a damaged Scout booster obtained from NASA. Mugu has four AN/FPS-16 precision radars. Three have the standard 5-yd. accuracy at ranges out to 200 mi. One has been modified to give it 500-mi. range. There are five S-band automatic tracking radars.

Naval Missile Facility, Pt. Arguello, about 100 mi. up the coast, is the PMR launch base for large rocket systems and is likely to be used in USAF Project Phoenix aimed at the development of economical multi-million-pound thrust space vehicle booster systems (AW Mar. 27, p. 50). At present, USAF is launching Lockheed Samos reconnaissance satellites from Arguello. National Aeronautics and Space Administration plans to begin launching Scout space vehicles from Pt. Arguello in the spring of 1962 to meet a requirement for polar orbit missions. Arguello is located in a right angle in the coastline which makes possible safe launches to the south or to the west. Arguello is also an important tracking and telemetry site. It will be one of the two PMR bases which will serve as command sites in Project Mercury manned orbital flights and the command to re-enter for a landing near Cape Canaveral will be given from there or from the station at Guaymas, Mexico, if the decision is made not to override timer-controlled re-entry. Any of the six command stations will be able to reset the timer. Arguello has two AN/FPS-16 precision radars on Tranquillon Peak, the highest ground in the area. One has the same 500-mi. range modification used at Pt. Mugu. There are also two SCR 584 mobile S-Band automatic tracking radars to handle large missiles and aircraft at ranges between 400 yd. and 480,000 yd.

San Nicolas Island, 50 mi. off the California coast, has a tracking and telemetry base and a runway for recovering target drone aircraft used over the Sea Test Range. It is equipped with a TLM-18 telemetry receiver and is one of the readout stations for NASA Tiros weather satellites. The 60-ft. dish reflector type antenna tracks automatically using a conical scanning pattern. It tracks at up to six degrees per second and has fast horizontal slew provisions to keep up with targets crossing at high elevation angles. San Nicolas also has four FPS-16 radars and four SCR 584 radars.

Marine Corps Air Station, Kaneohe, Oahu, is the crux of PMR downrange operations. Though its physical plant is far smaller and less costly than that of some of the other Pacific Missile Range stations, the Kaneohe PMR installation is the communications hub of the Central Pacific range sites and is the central point in the missile impact locator systems network which acoustically fixes the position at which ballistic missile warheads impact downrange.

Kokee Park, Kauai, Mercury Station No. 12 and the second Mercury command site in PMR, is now being checked out by NASA and installation contractors preparatory to transferring it to Chance Vought Range Systems Division which will operate and maintain the site under contract to PMR. The $7-million Kokee Park installation will be capable of tracking the Mercury capsule at ranges up to 700 mi. so long as it remains above an altitude of 100 mi. The limit is set by the curvature of the earth and no more power or antenna gain can be used by the FPS-16 radar and the Verlort (Very Long Range Tracking Radar) around which the installation is built.

Kokee Park is on the highest ground on the west end of the island of Kauai at an altitude of 3,600 ft. According to present plans for the orbit of the first Mercury capsule, Kokee will be straddled by two of the three planned passes and must be high enough to derive good look angles in all quandrants. The console at the Kokee Park telemetry and control center will be manned by a physician specializing in aerospace medicine, a capsule systems engineer and one of the seven astronauts designated as "capsule communicator," as at all the other command sites. The physician will monitor telemetered physiological data and the systems engineer will watch functioning of vehicle.

Communicator's Panel

The communicator's panel at Kokee Park includes a photograph of the panel in the Mercury capsule to aid him in visualizing the situation from the standpoint of the capsule pilot. His most important instrument will be a Mayday signal light which will flash on command from the capsule if an emergency develops. As a trained astronaut the communicator is in charge of the telemetry and control center. If the Mayday signal flashes, or he and his assistants conclude that the capsule must be recovered earlier than planned, the astronaut can ask the Mercury control center at Cape Canaveral to invoke the contingency recovery plan to re-enter the capsule at one of several safe places.

The command sites such as Kokee Park can reset the retrorocket ignition timer or can issue the ignition command directly if the Cape Canaveral command post directs it. The astronaut in the capsule can override any command from the ground. The trios of monitors at command sites will be able to check the firing of the three retrorockets, the jettison of the retrorocket assembly, periscope retraction, closing of the re-entry relay, deployment of the drogue chute, main chute or reserve

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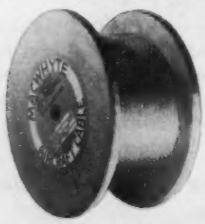

The four solid-fuel Douglas Skybolts carried beneath the wings can be launched as far as 1000 miles from their targets—making it unnecessary for the Stratofort to penetrate heavily defended enemy areas. Launched from their airborne base, the missiles are designed to follow a ballistic trajectory above the atmosphere, streaking toward pre-selected targets at hypersonic speeds.

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Barking Sands, Kauai, is a Navy fleet training facility operated by Pacific Missile Range as well as a satellite tracking station. It is equipped to recover target drones.

South Point, Hawaii, is a deep space probe tracking and telemetry station. It was started by Air Force Ballistic Missile Division in 1958 and was to be turned over to PMR as the permanent operator after the completion of the NASA P-14 magnetometer probe flight (AW Apr. 3, p. 32). Bendix Corp., as contractor to PMR, already has personnel on the site preparing to take over operations from Space Technology Laboratories, contractor to NASA.

Radio Interference

The $4-million station was established at South Point partly because the radio interference level there is extremely low and partly because its longitude is roughly midway between that of Cape Canaveral and Singapore and roughly opposite that of Manchester, England. The four stations are spaced evenly enough to keep a probe in deep space under constant observation.

The station is built around a TLM-18 receiver, which its operators designate a TLM-18-1 to indicate that it has undergone major modifications. It has been given interchangeable antenna feeds to give it flexibility in frequency selection and a parametric amplifier has been used in it to give it unusual sensitivity for a 60-ft. dish. The antenna serves two sensitive UHF receivers, two extremely sensitive VHF receivers and several broad-band receivers.

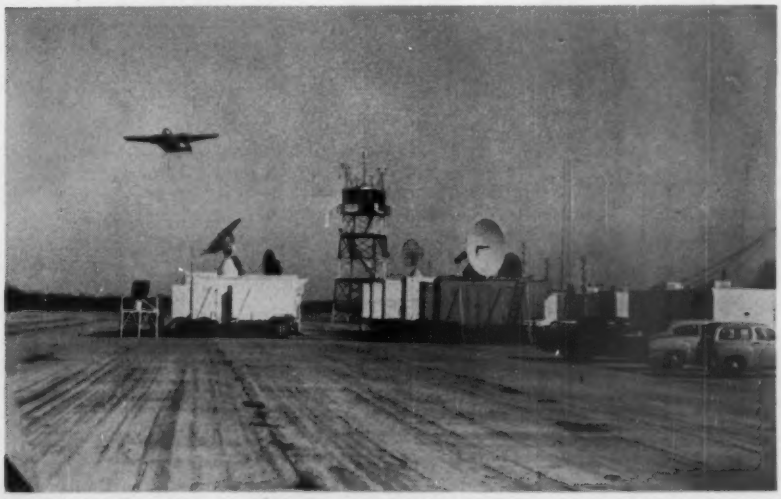
While South Point is intended mainly as a passive listening post for deep space probe projects, the station also works with a few "earthbound" satellites. As Station No. 10 in the Transit program, it is run under contract by New Mexico State University. It is also equipped with a relatively small transmitter with which it was able to interrogate Pioneer V out to a distance of 10 million mi.

South Point is now manned by 32 persons employed by the various contractors and agencies currently using the station.

Other Stations

Other important island stations in the PMR system are:

- **Canton Island** just north of Samoa is being established as a Project Mercury station and will be operable if the first manned orbital flight can be made on the originally scheduled date in July.
- **Tern Island,** Hawaii, is a Discoverer tracking site, but by far the greatest part of the Hawaii-based operations in support of Discoverer, Samos and Midas are conducted by the AFBMD station at Kaena Point, Oahu.
- **Wake and Midway Islands** are missile impact locator systems stations.
- **Eniwetok** is a missile impact locator system station in the PMR net and is a target for Air Force ICBMs launched from Vandenberg AFB. Aircraft equipped for infrared and optical measurements in Project PRESS will be based there. The facilities of Atomic Energy Commission's Eniwetok Proving Ground have been taken over by Pacific Missile Range since nuclear tests were halted in 1958.



BARKING SANDS instrumentation site provides Pacific Missile Range with telemetry and communications services for tracking space vehicles, missiles and pilotless target drones. Facility is entirely composed of mobile instrumentation vans utilized at various mainland PMR sites.

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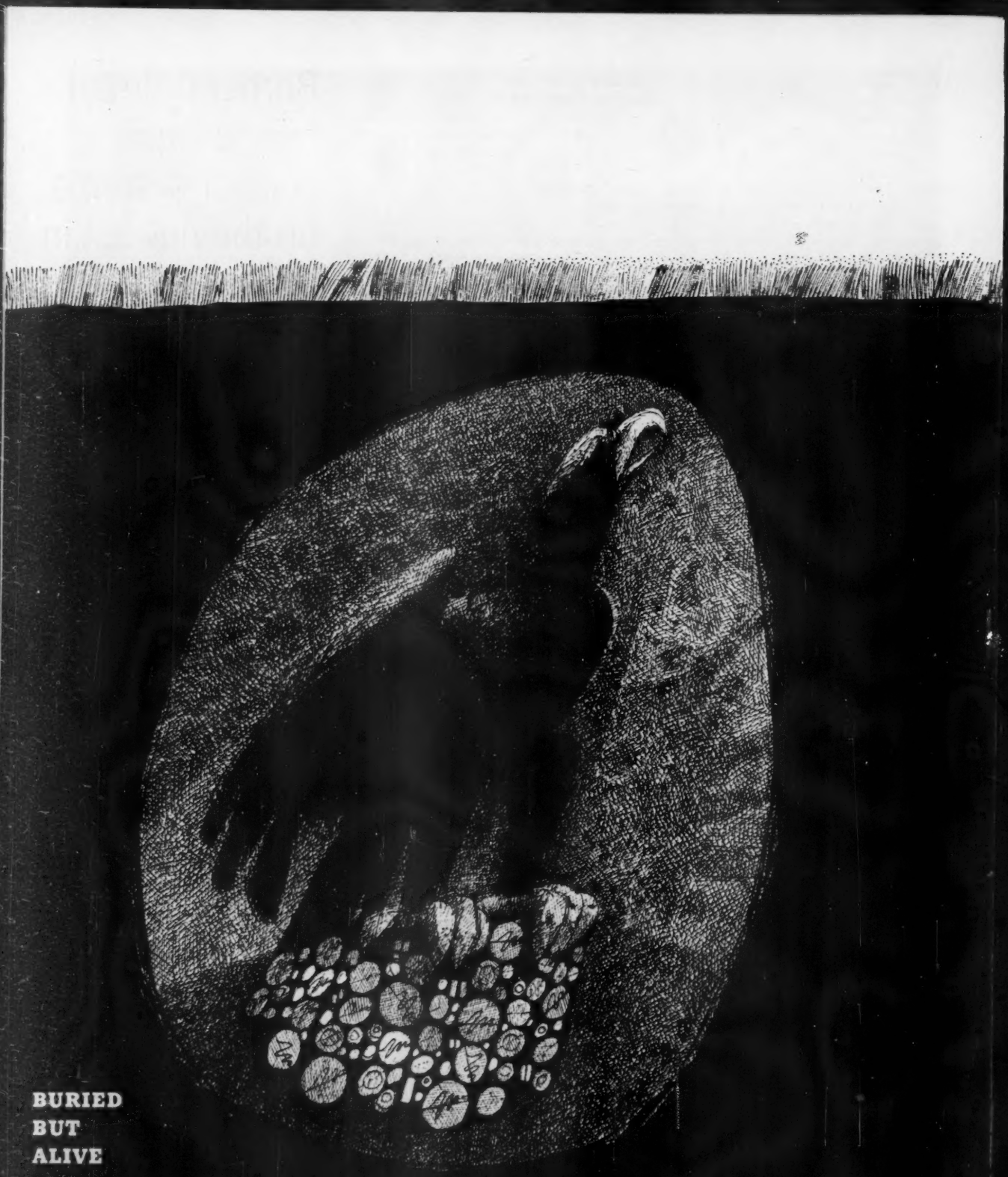


BURIED BUT ALIVE

Hidden in the earth, the Air Force Minutéman missile must remain ever ready. Though untended for weeks, months, even years, each of its thousands of components must function perfectly together if the button is pushed. This is the new order of reliability being fulfilled by Autonetics—designer of the Minuteman's critical guidance and control system.

Electromechanical Systems by **Autonetics** Division of North American Aviation

Operational Quail Longer Than Earlier Models

Operational version of McDonnell GAM 72A Quail decoy missile, now in service with SAC's 4135 Strategic Wing, is longer than development models, measuring about 13 ft. over-all and weighs about 1,200 lb. Added length could provide for either more fuel for the single General Electric J85 turbojet or for avionic equipment. SAC B-52Gs can carry up to four of the decoys in addition to the normal bomb load. Quail's wings remain folded until just before launch; the missiles slide down guiding rails on the package until they reach launch position, then unfold before dropaway from the B52G.

Flight Circuits Used Under High Radiation

Nuclear-powered aircraft and missile automatic flight control circuits have been successfully operated at radiation doses higher than would be normally experienced in actual applications, according to Chance Vought electronics engineers.

The company-designed circuits were exposed to 100 hr. of continuous radiation from a three-megawatt ground test nuclear reactor at Convair-Ft. Worth's nuclear aircraft research facility, receiving a neutron dose of approximately 50 million billion neutrons per square centimeter, with 20 of the 24 circuits still operating efficiently at the end of the test period. Vought engineers are convinced that three of the circuits which failed can pass the test after minor modification—the fourth was a transistorized circuit which failed at the anticipated point.

It had been included in the test to establish a failure level, which occurred while the reactor was being brought up to power level, at which time dosage was less than one ten-thousandth the 100-hr. dosage.

Circuits tested included glass, ceramic and metal electron tubes as well as the single transistor type. Although some components were distorted, discolored and underwent other changes during the exposure, circuit design flexibility enabled them to continue satisfactory operation.

Indications are that the circuits were of a type that also would have application in guidance and navigation systems. Test was under the cognizance of Paul Polishuk, Flight Control Laboratory, Wright Air Development Division.

Submarine Fuel Cells

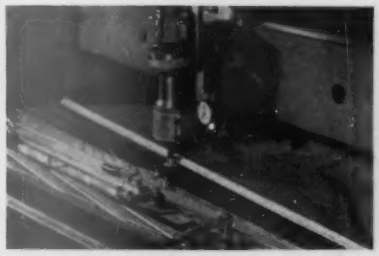
Washington—Navy believes a practical, long-life hydrocarbon fuel cell for powering submarines may be only a few years away. Such a system would permit conversion of diesel subs to make them quiet and drastically increase their submerged endurance, and permit construction of smaller subs at substantially less cost than nuclear-powered submarines.

Vice Adm. John T. Hayward, deputy chief of naval operations for development, told the House Science and Astronautics Committee in testimony released last week that the first practical cells for submarines probably will use methyl alcohol, extracting hydrogen by a catalytic process and producing electrical power directly from the energy of a chemical reaction. The only moving parts needed would be auxiliary equipment, chiefly pumps.

Energy conversion is achieved at efficiencies as high as 80%, although 50% is "more nearly the full power efficiency of today's cells—this is approximately the efficiency of the very best power generation plants," Adm. Hayward said. "And whereas most plants lose efficiency when operating at less than rated power, the fuel cell increases in efficiency at lower power," he said.

DESIGNING WITH HEXCEL

Aluminum Honeycomb: Forming and Contouring



Contouring Aluminum Honeycomb with Apex Router

Forming and contouring of aluminum honeycomb can be achieved simply, successfully and economically. Honeycomb contouring operations once thought extremely difficult have now become commonplace.

Curved panels are manufactured by roll-forming expanded honeycomb and bonding the separate pieces together. With normal sheet-metal rolls, cylindrical and spherical radii as small as 5 to 10 T are produced in aluminum honeycomb, while special techniques have been developed to form parts with radii as small as twice the thickness of the honeycomb core itself. By filling and milling, routing of unsupported core, and chem-milling, three-dimensional carving of honeycomb core materials makes possible the assembly of complex contoured structures.

High-speed routers account for most production contouring of honeycomb materials; a small jeweler's saw cupped on a vertical spindle is the usual cutting device. Aluminum and reinforced plastic honeycomb are simple to carve with router-type equipment, and the applications of honeycomb produced in this manner are many: contoured cores for rotor blades, control surfaces, conforming doors, duct assemblies.

Hexcel can assist designers and manufacturers in any honeycomb contouring and forming requirement . . . can perform the operation at both its Berkeley and Havre de Grace plants or recommend local manufacturers. Call on Hexcel's experience and technology in every phase of honeycomb development and production. See the Hexcel brochure, **This is Hexcel Honeycomb,** in Sweet's Product Catalog File or write Dept. 4-E

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STUDENT PILOT from Bitburg, Germany, starts an F-105D at Nellis AFB for his first checkout ride. Two extra cartridges are carried aboard the aircraft, making it independent of ground starters. Bitburg is first overseas base to be equipped with F-105s.

TAC Trains Pilots for F-105D Missions

By William S. Reed

Nellis AFB, Nev.—First class of 21 student pilots has started a 61-day course in the Republic F-105D as part of Tactical Air Command's program for a broad all-weather nuclear capability.

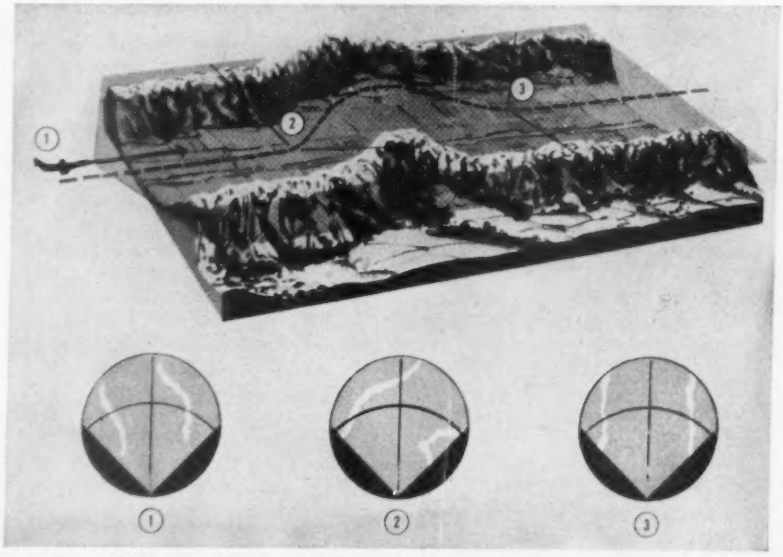
After graduation, TAC plans to send the pilots to Brookley AFB, Ala., to take delivery on the new "D" models. After a local flight to check out combat and navigation equipment, they will ferry the Thunderchiefs to the 36th Fighter-Bomber Wing, Bitburg Air Base, Germany, home station of most of the students and first overseas base to be equipped with the aircraft.

Intensive Training

The F-105D, together with related flight and ground support equipment, officially named the Thunderstick Weapon System, will probably require more intensive transition training and academic study than any other new weapon that TAC has phased into its inventory. However, the transition will not be just concerned with learning to fly a new aircraft but more with learning the new systems and the methods of using them. Only 5½ hr. of flying time out of a total of 45 hr. will be devoted to aircraft transition. More than half of the flying time—24½ hr.—will be devoted to radar navigation and simulated combat missions illustrating the techniques used to deliver a weapon on target under all weather conditions.

Neither instructors nor students of the 4520th Combat Crew Training Group expect that the departing graduate will be able to exploit the weapon system to its maximum immediately upon returning to his unit. Reasonable levels of proficiency and combat readiness will be attained only after extensive field operation and unit training taking from 8 to 12 months continuous practice with all equipment operating.

Most practicing fighter pilots are familiar with the air-to-air search and ranging radar with automatic tracking used in interceptors since the F-86D. Also familiar is the air-to-ground ranging radar and multiple functions of the computing gunsight used for air-to-air gunnery, air-to-ground gunnery and rocketry, dive bombing and other aerial weapon delivery techniques. But now in his further role as radar operator-navigator-bombardier, the Thunderstick pilot is faced with a really complex



TERRAIN AVOIDANCE mode of the North American Search and Ranging Radar (NASARR) will provide scope pictures similar to those shown in the drawings enabling a pilot to fly at low level in bad weather. Developed by Autonetics Division of North American Aviation, the system is installed in the Republic F-105D.

array of necessary equipment. In addition to the above gear, the F-105D carries R-14 ground map, terrain avoidance and contour map radar (Autonetics Division of North American), AN/APN-131 doppler navigation gear (Laboratory for Electronics), FC-5 flight control system (GE) and AN/ASG-19 fire control system (GE). For the first time, a fighter plane has been equipped with enough avionic gear to make it capable of bombing an unseen target with accuracy from level flight.

Initial training for the F-105D program started some months ago when a team of engineers from Republic Aviation Corp. and Autonetics Division of North American Aviation, developers of the North American Search and Ranging Radar (NASARR), made a swing through Europe to brief prospective Thunderstick pilots. TAC also borrowed seven top radar navigator-bombardiers from SAC to serve as aerial and ground instructors in the NASARR system. In addition to their professional qualifications, the seven navigators were chosen because of their ability to teach since one major obstacle they must continually overcome is the general reluctance of fighter pilots to take instruction from navigators.

They have succeeded well as indicated by the praise the instructors and students at Nellis have for their professional ability.

In addition to teaching the operation and functioning of the NASARR system, the radar navigators discuss and analyze radar target materials, inherent radar errors, and familiarize students with the theory, origin and use of various types of radar prediction.

REPUBLIC F-105s practice formation flying as part of the ground support and non-nuclear strike tactics prescribed as a part of the training program at the Combat Crew Training Center, which is located at Nellis AFB, Nev.

Some Snags

There have been some snags in the Nellis program: Instead of the three T-39s originally scheduled, only one was available at the start of the program. Also, developmental problems with the NASARR system in both the F-105 and the T-39 have not been reduced to the point where in-commission rates are high enough to permit even the most optimistic student or instructor to expect that all flights scheduled will be completed with all equipment functioning.

The two biggest problems with the NASARR today are keeping the system in calibration and eliminating some of the gross errors in the terrain avoidance mode of operation, Air Force pilots say. This is despite the more than 70 modifications made in F-105D electronic gear before the aircraft were delivered to Nellis. Not all the changes were made to the NASARR system alone nor do all the existing difficulties lie within NASARR. According to Autonetic's William G. Fort, there is no one single major problem to which any of the trouble can be traced. Some malfunctions occur in the system itself while many are traceable to any one of the numerous inputs which must all be correct before the system outputs can be exact.

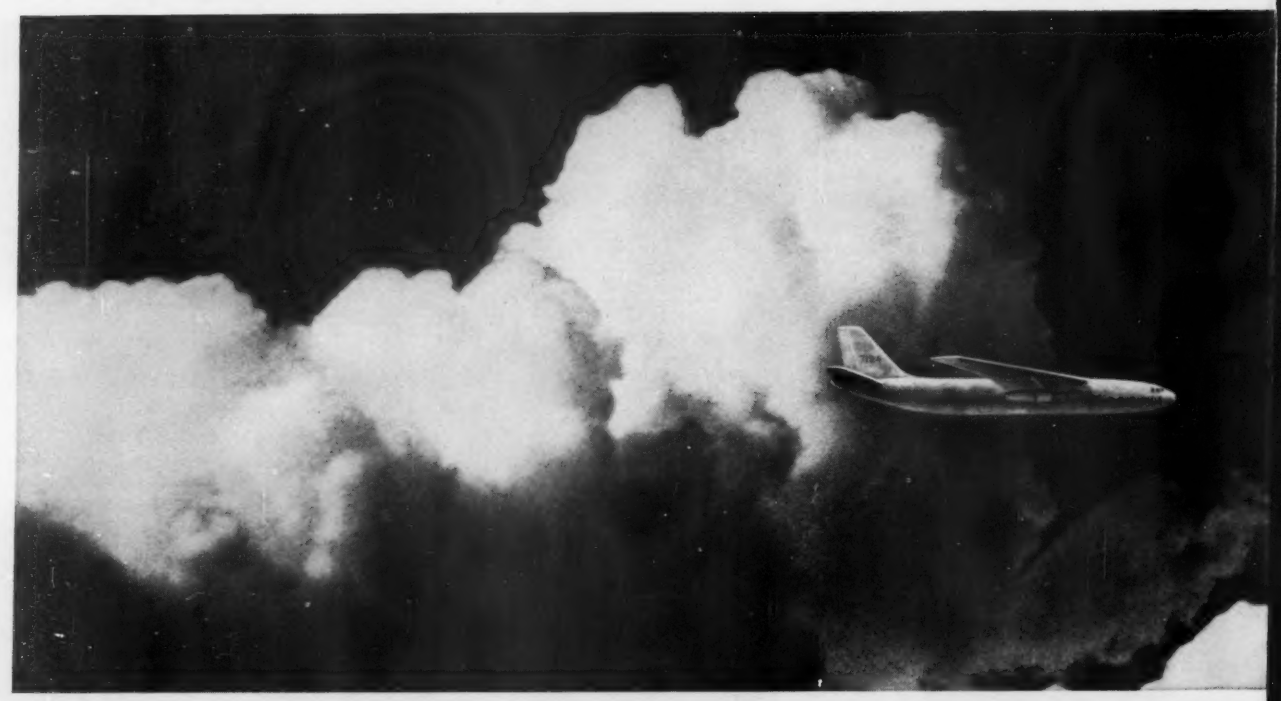
Some of the operating parameters NASARR must sense correctly before it operates properly are angle of attack, Mach number, airspeed, free air temperature, altitude and attitude. Most of these come from the ship's system or from transducers which also supply information to other systems. The terrain avoidance mode, for example, must sense the angle of attack of the aircraft so that the antenna is correctly aligned. For contour mapping, the antenna must be aligned with the horizon to present a picture of the terrain above a certain reference altitude.

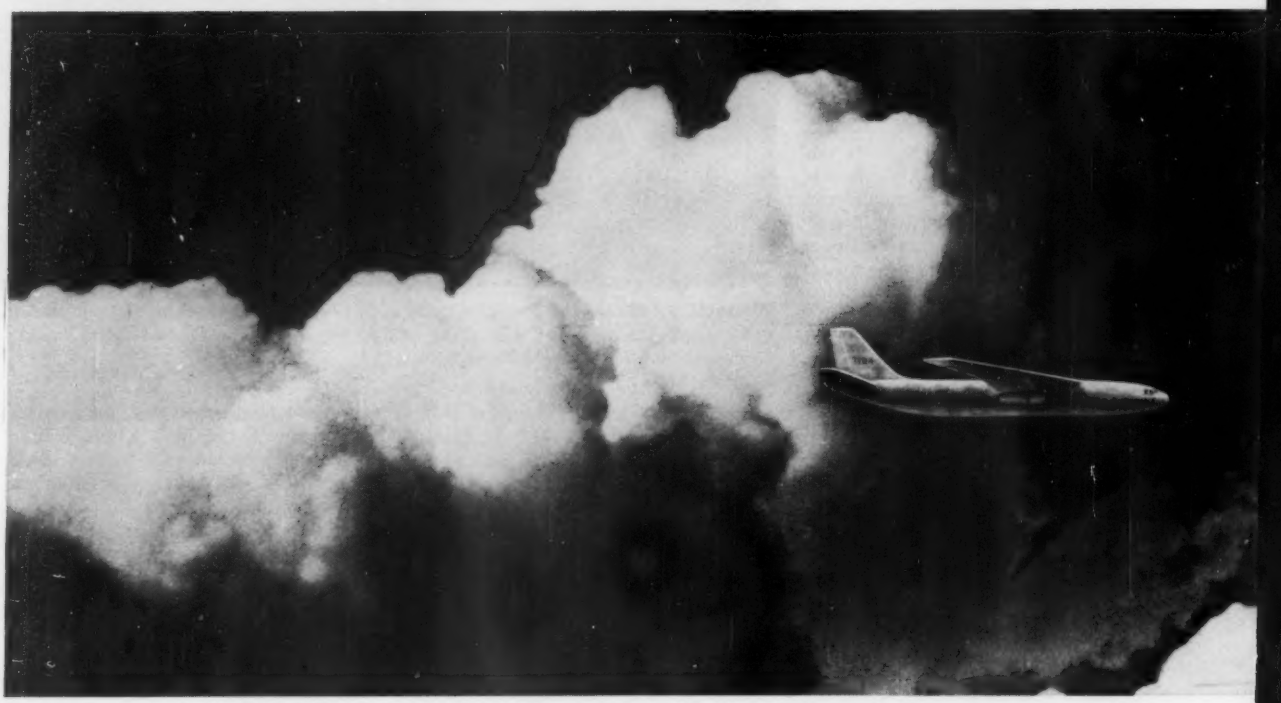
Although it is a familiar theme in the age of complicated weapon systems, it can be said that while each individual component works well on its own, integrating them into a single unit operating harmoniously creates problems when going from developmental to production items.

Intensive effort on the part of Republic and Autonetics engineers and representatives of General Electric is eliminating interface problems and system incompatibilities as fast as they can be discovered.

Personnel Enthusiastic

If the problems have any one derivative, it is in the ambition of the concept of trying to put into one fighter plane for the operation of one man a weapon system more complicated than any previously conceived. But everyone connected with the F-105D training program is enthusiastically concerned with getting the weapon system into the field as rapidly as possible. From the mechanics and technicians working on the flight line to the com-

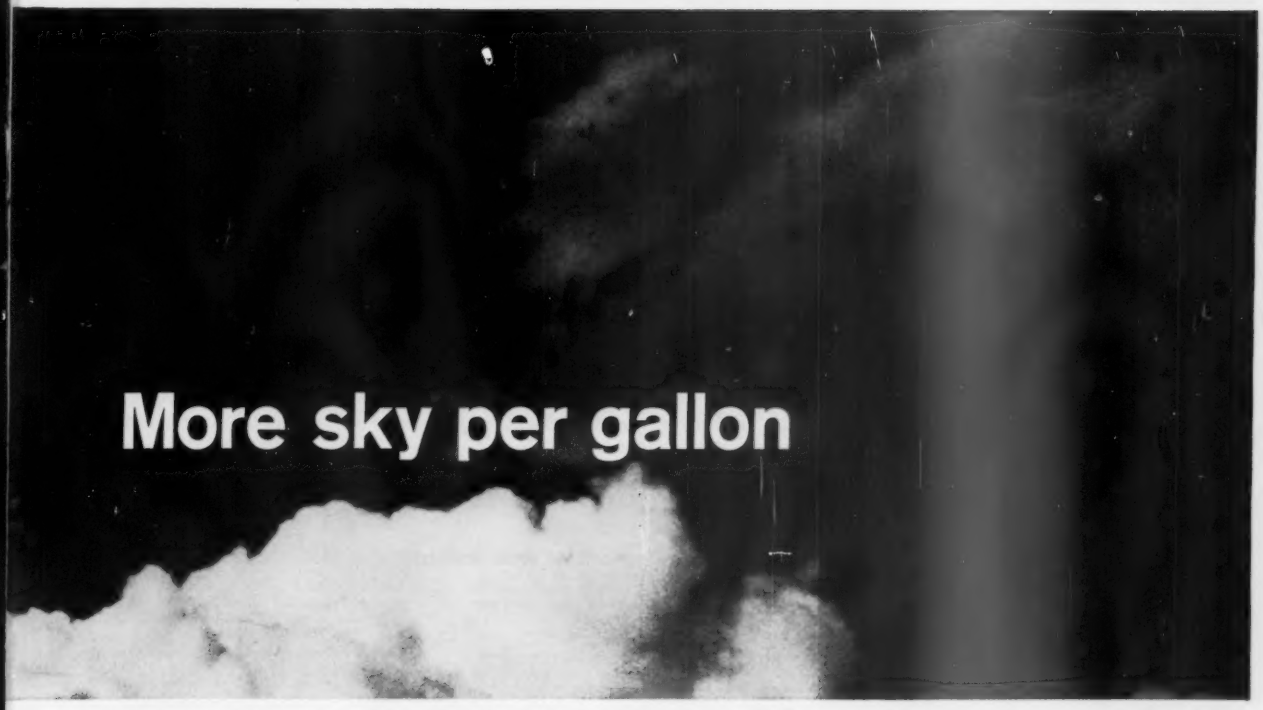




Northrop's Laminar Flow Control will enable large aircraft to fly up to twice as far as they now can, and stay aloft proportionately longer, on the same amount of fuel. Or it will permit them to carry heavier payloads over a given distance. And it will accomplish this without increasing the airplane's size, weight, or engine power.

Laminar Flow Control is a revolutionary technique developed by Northrop for reducing friction drag on an airplane in flight. This drag is caused by the turbulence of the boundary layer of air as it flows over the surfaces of the plane. By drawing off this turbulent air through paper-thin slots in the aircraft skin with a suction system, and exhausting it in the direction of thrust, a smooth "laminar flow" of air is obtained.

The implications of Laminar Flow Control are far-reaching. To commercial operators it can mean substantial cost savings on long distance flights, and make



possible non-stop flights over greatly increased distances. To the military, it will be immensely important for surveillance and airborne alert missions, or for any operation requiring aircraft to stay aloft over long periods. On logistic missions, planes can fly in and out of trouble spots without refueling. Dependence on overseas bases will be reduced.

Northrop is conducting a continuing research program for the U.S. Air Force to investigate the applications of Laminar Flow Control to many kinds and phases of flight. Two airplanes are now being modified under a separate Air Force contract to demonstrate the practicability of this new aerodynamic technique in day-to-day operation.

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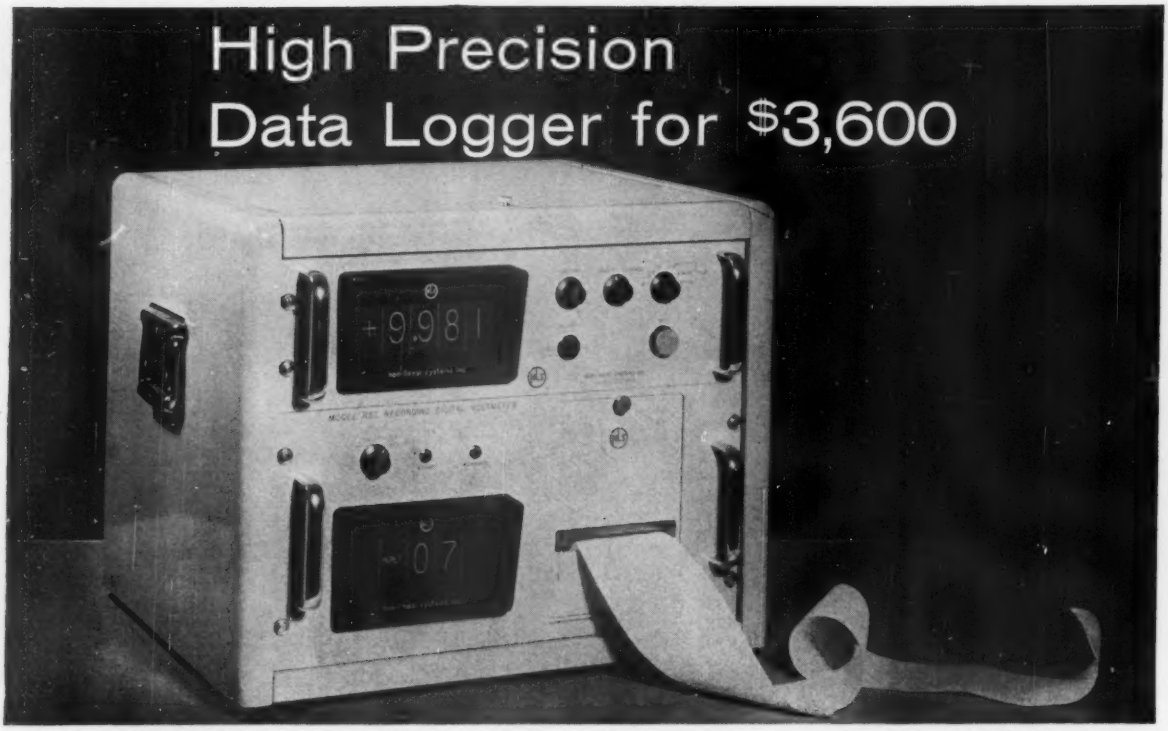
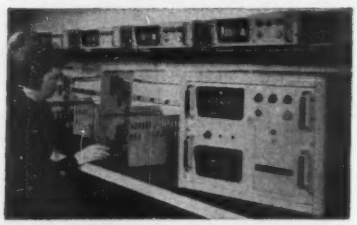
High Precision Data Logger for $3,600

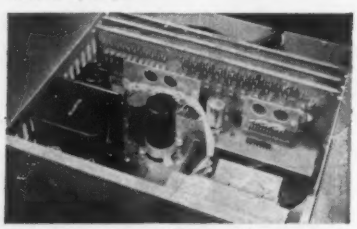


The RS2 Recording Digital Voltmeter — now in volume production at Non-Linear Systems, Inc. — scans up to 20 double-pole input channels . . . measures DC voltage from ±0.001 to ±999.9 with ±0.01% accuracy . . . and records input channel number and the 4-digit voltage measurement. Uses include research and development, quality control, environmental and reliability testing.



Volume production and simplified controls of the RS2 account for its low cost — half to a third less than custom-built units.

Plug-in stepping switches in the digital voltmeter section of the RS2 permit replacement of all switches and decade resistors in minutes instead of days.



Note the compact, plug-in modular design of the scanner-printer section of the RS2.

NLS Reports on Low-Cost, Standard Data Logger

A low-cost automatic data logger built as an integrated scanning, measuring and printing system — the RS2 Recording Digital Voltmeter — is now in volume production at Non-Linear Systems, Inc.

This economy-priced NLS logger is designed for applications requiring high accuracy and low cost without need for the higher speed and greater input capacity of higher cost NLS systems. Simplified controls offer several automatic and manual modes of operation to meet the needs of a great number of applications.

While utilizing many circuits field-tested for six years in thousands of NLS digital voltmeters, the RS2 has undergone extensive testing as a standard, complete system. It is delivered ready to use, without need for additional engineering or complex interconnections.

Call your NLS regional office or representative for a demonstration, or write NLS.

RS2 BRIEF SPECIFICATIONS

Visual Indication: 4-digit voltage reading with correct polarity and range. 2 digits for input channel identification.
Range-Polarity Indication: automatic
Functions: scanning up to 20-double-pole channels; measuring DC voltage from ±0.001 to ±999.9 in ranges of ±9.999/99.99/999.9; printing channel number, 4-digit reading, polarity and decimal point placement.
Accuracy: ±0.01% of full scale on each range.
Speed: 2 seconds average for each data point scanned, measured and recorded.
Scanner Operation Modes: AUTO CYCLE — system continually repeats automatic scanning cycle from channel 00 to 19. ONE CYCLE — system automatically stops after scanning channel 19. PRINT — one input is measured manually advanced one channel at a time by depressing front panel ADVANCE button.
AC Voltage: Use NLS AC/DC Converter.
Low-Level DC: Use NLS Model 140 Preamplifier.
Input Impedance: 10 megs on all ranges.
Size: 14" high, 15¼" deep for 19" rack.
Delivery: From stock. 30 days, maximum, should stocks become depleted.

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR, CALIFORNIA

manders of TAC, all are convinced that the concept is sound and that the Thunderstick is potentially a very powerful weapon.

To illustrate the dependence of the pilot on the avionics gear carried by the F-105D, consider a typical mission flown by the students at Nellis:

• **Pre-mission planning** includes all the conventional information pertaining to target location, defenses, location, etc., but with the inclusion of radar target predictions. This is a new phase to TAC pilots and one that will receive considerable attention in future training.

• **After takeoff,** the pilot climbs on course with the autopilot holding a constant Mach number climb and a constant heading. The doppler navigator is preset to the base location and gives a constant range and bearing to target or from base.

• **At cruising altitude,** the autopilot maintains heading and either constant altitude or constant Mach number for best cruise control. Precomputed time and distance points can be checked against points of known radar return using the radar mapping function. Errors which occur in the doppler system can be canceled out by slewing the coordinates of the check points into the system.

• **Rendezvous with a tanker** in a certain area can be effected by homing devices aboard the fighter using radar mapping and doppler navigation devices.

• **Once a predetermined point** has been reached, the pilot can let down to within a few feet of the ground underneath radar detection capabilities and continue to the target depending on the terrain avoidance radar to guide him over or around high ground in all weather. Contour mapping provides an additional means of tracking into a target by cross-checking the doppler system and augmenting the lessened radar return caused by low level flying.

• **Identification** of the initial point (IP) is accomplished by comparing the actual radar return with the predicted return. From this point the target can be attacked by any one of several different methods: High altitude horizontal bombing, low level drogue retarded laydown, toss bombing or over-the-shoulder delivery. Even if the target itself does not have a sufficient radar return, it can be attacked by using an offset target; that is, using the distance and direction of the target from the IP, the bombing computer automatically will release the bomb by computing a "pickle point" from a remote reference. In all methods of attacking a target, the bombing computer guides the aircraft through the autopilot, releases the bomb and even performs evasive action and recovery to a normal attitude.

• **Following the attack,** the pilot can return to base or to a tanker using the same navigational means as on the outward flight.

• **Should a radio blackout** have been ordered at the home base or at a remote recovery base, descent through an overcast and even a low approach to within close proximity of the runway can be made by navigating the aircraft to the base by radar, slewing in the doppler to zero out the error and, after letting down on an outbound radial, tracking inbound on a predetermined heading. Pilots who have practiced this technique report that it is highly accurate and as easy as a radio range or omni range letdown.

Despite this dependence on electronics and the NASARR in particular, the F-105D can render tactical support with conventional weapons including high explosive bombs, rockets and gunnery (with the M-61 Vulcan cannon which is designed to fire 4,000 rounds per minute). With the recent emphasis placed by the Kennedy Administration on tactical weapons, the training group expects that the present course may be modified to include more than the one ground support mission now scheduled.

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First: resolution has been improved to 0.002% of reading. Second: new and greater accuracy is 0.015% of *reading* in ranges to 150 psi and 0.025% of *reading* in ranges of 150 to 500 psi. (Both percentages formerly were *full scale.*)

Accuracy in the calibration of gage or absolute pressure measuring instruments – such as CEC's new Miniature Electromanometer System – begins with the 6-201. This pneumatic deadweight piston gage covers six pressure ranges from 1.5 to 500 psi. A portable, true primary standard, the 6-201 utilizes mass, length and time for its references. Accuracy depends only upon the dimensional accuracy of its component parts.

For complete information, call your nearest CEC sales and service office or write for Bulletin CEC 1581-X33.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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PRODUCTION BRIEFING

Hallamore Electronics Division of the Siegler Corp. has received an initial contract of approximately $350,000 from Convair Astronautics Division of General Dynamics to participate in the Centaur space booster program. The contract calls for the design and manufacture of a television instrumentation system to monitor the liquid hydrogen fuel tanks in the Centaur vehicle.

Chrysler Corp. will continue to cover installation and checkout requirements for the Jupiter missile system overseas under the terms of a $2,141,000 contract awarded by the Army.

California Computer Products, Inc., has received a $555,075 NASA contract to produce the control system for a series of seven Nimbus weather observation satellites which the U. S. expects to orbit in 1962. The system will weigh about 20 lb. and will contain the approximate volume of a large city telephone directory.

Convair-Ft. Worth Division of General Dynamics Corp. will assist the Air Force in standardizing results of irradiation experiments under a contract from Wright Air Development Division, Dayton, Ohio. Nuclear engineers, operating a mobile laboratory containing a cobalt-60 radiation source, will tour various facilities throughout the country calibrating instrumentation and measuring sources. Results of the three-month program will be submitted to WADD's Nuclear Laboratories.

Electro Nuclear Systems Corp. will explore equipment requirements for locating downed airmen under a feasibility study contract awarded by the Navy. The Special Products Division research group will consider new and more powerful energy sources for signal equipment and adaptation of electronic techniques to the problems of rescue.

Gladding, McBean & Co, has received a $171,000 contract from Raytheon Mfg. Co. for further production of ceramic radomes for use on the Sparrow III missile and a contract from Generale Aeronautique Marcel Dassault, French missile manufacturer, for production of a number of prototype ceramic radomes.

Beckman Instruments, Inc., will design, develop and build computing equipment for reduction of doppler tracking data under terms of a $97,631 NASA contract. The equipment, called an automatic doppler cycle counter, will be installed in the Computation

Division of the George C. Marshall Space Flight Center where doppler tracking data on space vehicles and spacecraft received by numerous tracking stations will be forwarded for analysis.

Western Electric Co. has been awarded a $4,029,019 Army contract for production engineering services for the Nike Hercules air defense system. Bell Telephone Laboratories and Douglas Aircraft Co. will also share in the activity.

Flexible Tubing Corp. has received a $655,000 contract from the Air Force for 3,000 pneumatic starter duct assemblies for use with gas turbine jet starting units. The assemblies have a life of 4,000 starts and are effective in temperatures from −65F to 130F.

Olin Mathieson Chemical Corp. has been awarded a $250,000 Navy contract for basic research studies in the field of high temperature resistant boron-containing polymers.

Oak Ridge National Laboratory is constructing an experimental facility which may be capable of developing temperatures in billions of degrees. Labeled Direct Current Experiment No. 2 (DCX-2), the facility will be a "hot ion" injection system with an energy of 600,000 electron volts. The $1.6 million project is part of the Atomic Energy Commission's long-range effort to control fusion reaction for production of electric power.

Collins Radio Co. announced initial deliveries on a $1,008,990 order for airborne high frequency single sideband communication systems to the British Ministry of Aviation for use on RAF Argosy C.1. aircraft.

Weston Hydraulics, Ltd., subsidiary of Borg-Warner, has received a contract for the development of an electro hot-gas servo valve for the Army Mauler missile. The unit, which is part of the flight control system, is powered by hot gases expended by the solid propellant cartridge.

Martin Co. has received a $90,000 Air Force contract for development of a superconducting, 20-microsecond cryogenic delay line to operate in microwave frequencies between 4 and 12 kmc.

Vitro Electronics, a division of Vitro Corp. of America, has been awarded a $153,734 FAA contract for marker beacon and compass locator transmitters, antenna and feeder assemblies and related equipment.

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Its Type 4-333 Precision Pressure Balance is designed to measure differential, gage and absolute pressures to 100 psi. The system's Type 1-156 Servo Amplifier is 100% solid-state in design and is fabricated on circuit card modules. It includes an integral power supply for operation on 115v, 60 cps line voltage. A multi-channel adapter, available as an accessory for the system, can be used as a switching unit for two to six pressure balances sharing a single servo amplifier.

This precise new CEC system provides secondary pressure standard accuracies for laboratory, field or industrial applications ranging from process control to calibration service. Its small size and high-level output assure easy integration into major system designs.

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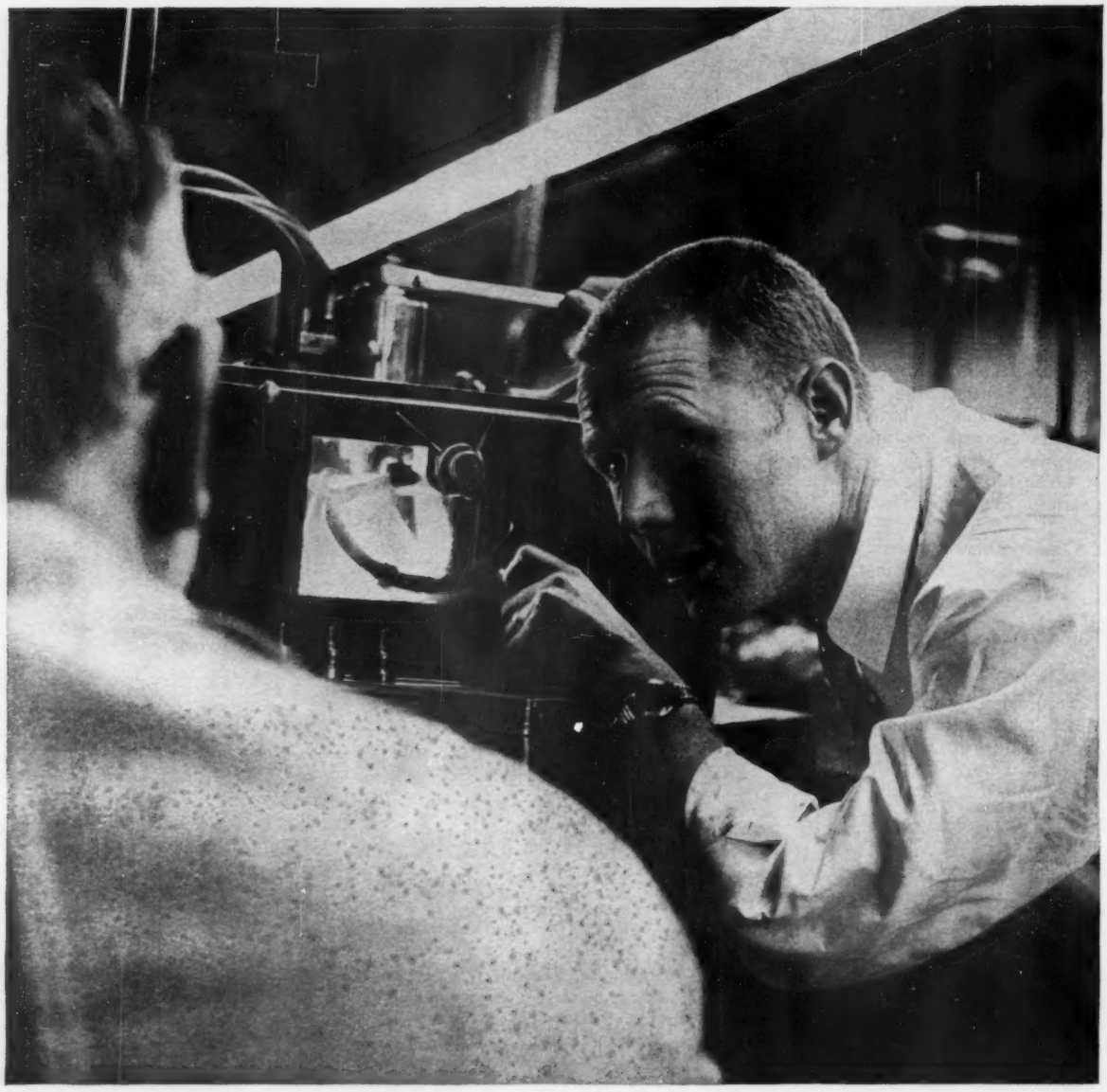

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He is Richard O'Hara a Delavan Project Engineer who designs and develops after-burner fuel injectors and fuel nozzles. Ask him what kind of performance he wants from one of his fuel nozzle designs, he will tell you "The performance defined by customer specifications". And, this pretty well sums up the attitude of every member of Delavan's 40 man engineering department. Envelope dimensions, special tests, and reliability requirements are predetermined by you, the engine builder. Tell us these specifications and we'll design and manufacture your fuel nozzles . . . . on time and economically.

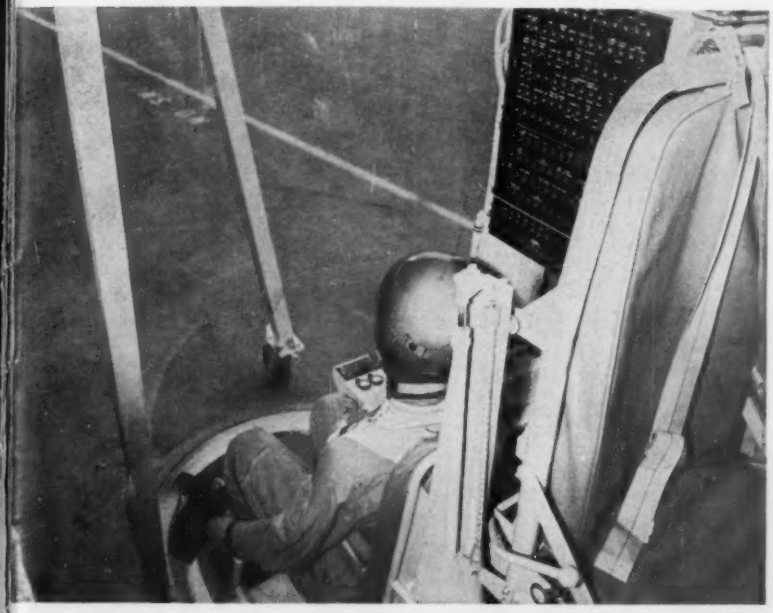
get to know Delavan fuel injector specialists

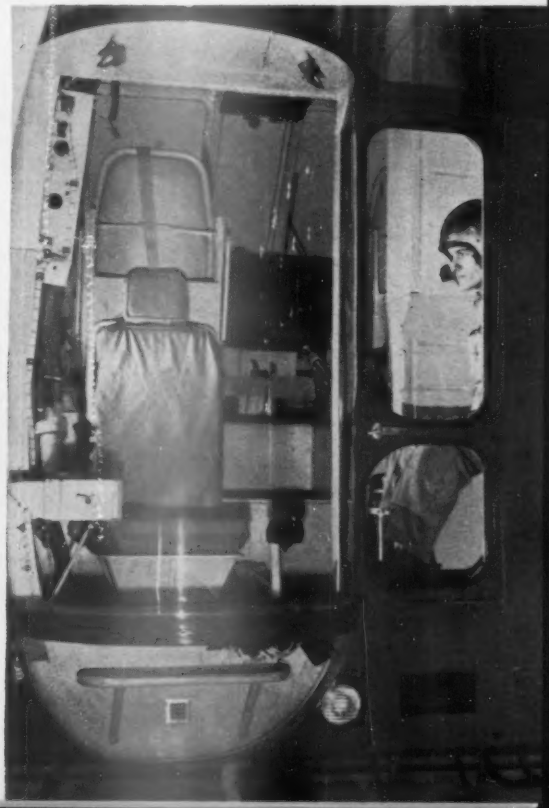
DELAVAN
Manufacturing Company
WEST DES MOINES, IOWA

Cockpit mockup of the turbine-powered Sikorsky S-64, successor to the S-60 Skycrane, has been shipped to Germany for evaluation by German Air Ministry. Behind bubble (right) is aft facing third seat from which aircraft may be operated during loading and unloading.

Sikorsky S-64 Cockpit Mockup Shipped to Germany

Mockup has a complete set of controls, is completely instrumented and lighted. Powered by two Pratt & Whitney JFTD-12 gas turbine engines, the S-64 will have a payload capacity of approximately 17,600 lb. First aircraft is scheduled for flight-testing at the end of the year (AW Nov. 28, p. 23).

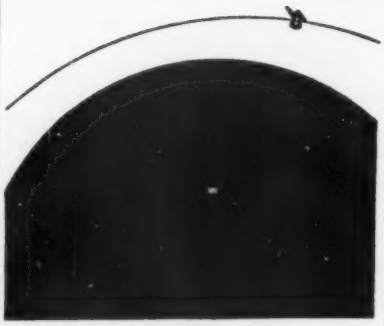




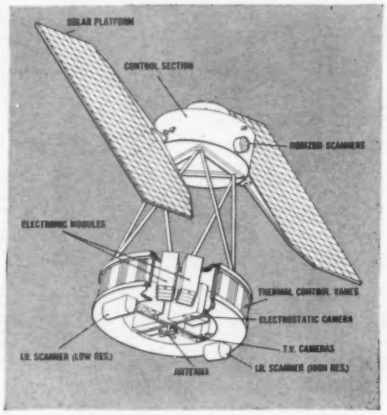
FAA Civil Aviation Estimates—1960

Item	Calendar 1959 (actual)	Calendar 1960 (estimated)	Percent Change
Number of U. S. active civil aircraft	70,747	78,000	+10
Number of scheduled air carrier aircraft	1,850	1,850	0
Turbojet 4 engine	84	190	+126
Turboprop 4 engine	178	190	+ 7
2 engine	35	45	+29
Piston 4 engine	869	785	−10
2 engine	661	615	− 7
Rotorcraft	23	25	+ 9
Number of civil aircraft manufactured	8,242	8,060	− 2
Single-engine 1–3 place	1,649	1,400	−15
Single-engine 4 place	5,136	5,190	+ 1
Twin-engine 4–19 place	1,017	1,060	+ 4
Transport type aircraft	262	235	−10
Rotorcraft	178	185	+ 4
Total airframe weight (thousand lb.)	23,132	27,000	+17
Value—aircraft & parts ($ millions)	989	1,350	+37
Number of U. S. civil and military airports and airfields	6,426	6,800	+ 6
Number of airman certificates issued:[1]			
Student pilots	67,618	57,100	−16
Private pilots	19,445	26,800	+38
Commercial pilots	13,344	14,400	+ 8
Airline transport pilots	3,728	4,300	+15
Mechanics	5,656	6,500	+15
Federal airways air traffic activity:			
Landings and takeoffs, FAA towers	26,905,856	25,752,000	− 4
Aircraft handled (IFR departures times two, plus IFR overs)	9,734,504	9,641,000	− 1
Scheduled air carrier operations:			
Revenue passengers enplaned—total (thousands)	59,819	62,250	+ 4
Domestic	54,768	56,500	+ 3
Foreign and overseas	5,151	5,750	+12
Revenue passenger-miles—total (thousands)	36,447,872	38,500,000	+ 6
Domestic	29,269,033	30,300,000	+ 4
Foreign and overseas	6,918,839	8,200,000	+19
Total passenger-miles—total (thousands)	37,579,548	40,100,000	+ 7
Domestic	30,400,699	31,600,000	+ 4
Foreign and overseas	7,178,849	8,500,000	+18
Revenue plane-miles—total (thousands)[2]	1,001,638	996,000	− 1
Domestic	845,721	834,000	− 1
Foreign and overseas	172,090	162,000	− 6
Express and freight ton-miles—total (thousands)[2]	638,554	706,000	+11
Domestic	448,070	482,000	+ 8
Foreign and overseas	190,584	224,000	+18
Passenger fatalities—total	257 (9 acc.)	337 (12 acc.)	....
Domestic	198 (8 acc.)	327 (10 acc.)	....
Foreign and overseas	59 (1 acc.)	10 (2 acc.)	....
Passenger fatalities per 100 million passenger-miles flown—total	0.7	0.8	....
Domestic[3]	0.7	1.0	....
Foreign and overseas	0.8	0.1	....

[1] Includes original issuances and additional ratings.
[2] Includes all-cargo carriers.
[3] Includes United-TWA collision at New York.



PROJECT NIMBUS



Nimbus is the second step in NASA's research and development program to study weather technology. Differing from its predecessor, Tiros, Nimbus will view the Earth at all times.

Orbit—Weighing approximately 650 lbs., Nimbus will circle the earth every 108 minutes in a 600 mile-high polar orbit.

Equipment—As many as 6 TV cameras, plus infrared measuring devices, tape recorders, telemetry and command instruments will be contained in the satellite.

Data Acquisition—Cloud pictures and other information will be played back on command to U.S. meteorologists at Fairbanks, Alaska. Foreign scientists, also, will be invited to participate in the program.

Control and Stabilization—A specially built system will keep TV cameras always oriented toward the earth and permit cameras to view particular sectors of the global cloud pattern.

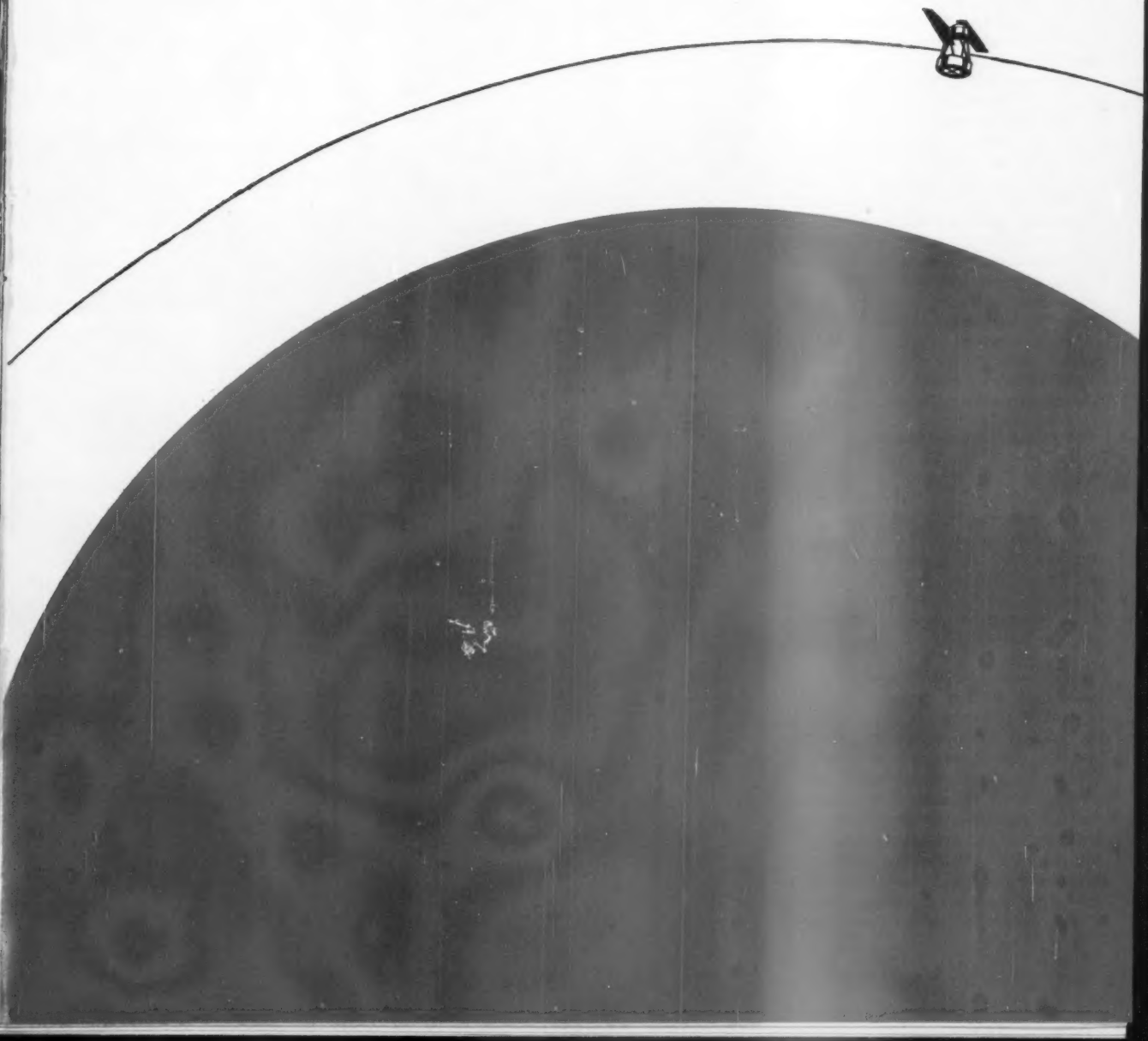
General Electric's Missile and Space Vehicle Department will provide systems integration for Nimbus, and will develop the control and stabilization system. MSVD is a department of the G.E. Defense Electronics Division. 160-03

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT, PHILADELPHIA, PA

NIMBUS will be America's next-generation weather satellite in space. Continually viewing the globe with TV cameras and other sensors, Nimbus will help man forecast the weather and learn more about its causes. General Electric's Missile and Space Vehicle Department is constructing the space craft and providing systems integration for the system designed by the National Aeronautics and Space Administration.

GENERAL ELECTRIC



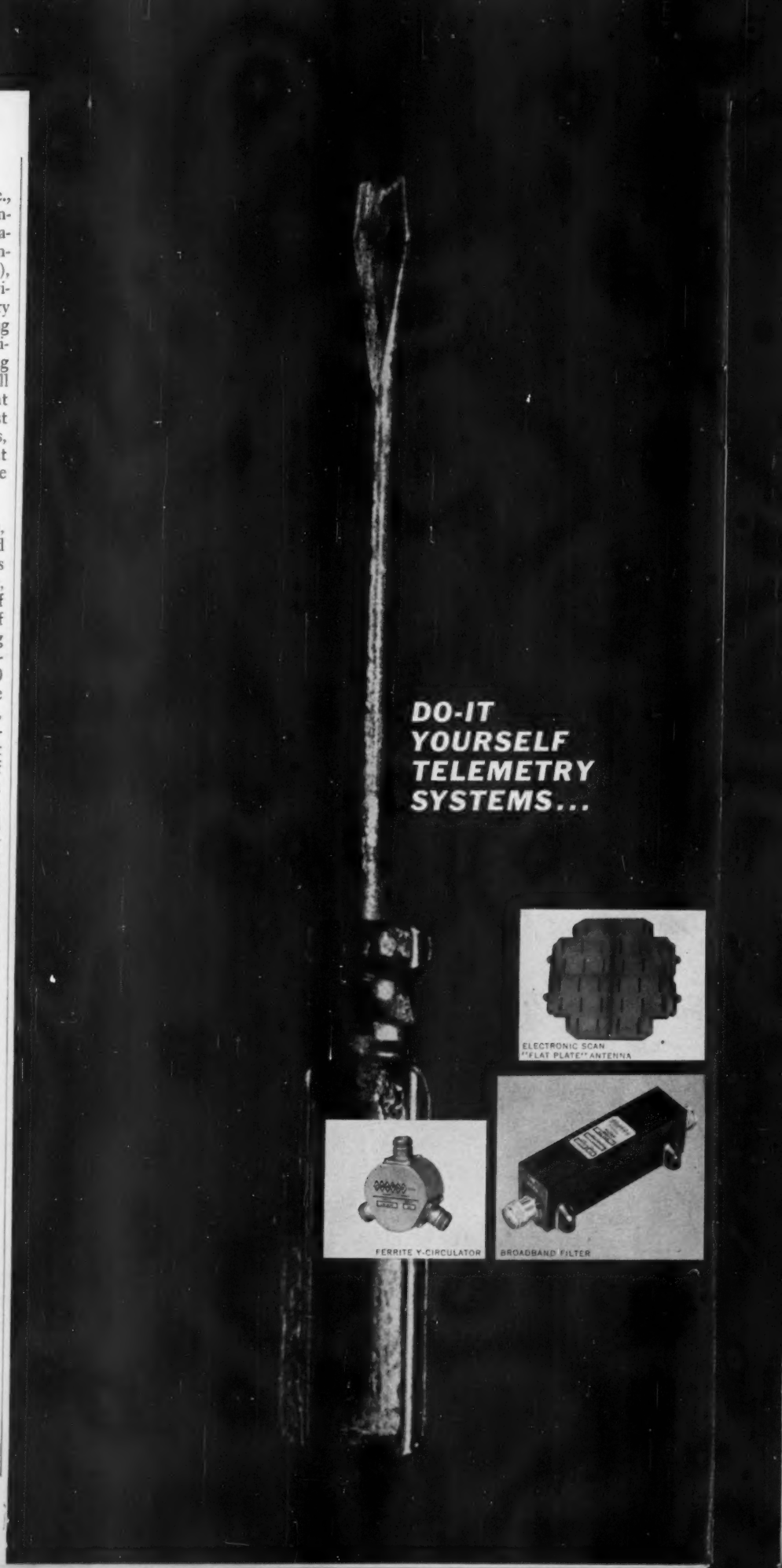
New Offerings

Idaho Maryland Industries, Inc., Studio City, Calif.; business is conducted through five divisions: Sierra-Schroeder Controls Division (fluid control devices for aircraft and missiles), Ferro Cast Division, Magnetics Division (precision recording and memory devices), Universal Research & Testing Laboratories Division, and Iteeco Division. Offering is 1,155,521 outstanding shares of capital stock, some or all shares for public sale by the present holders thereof on the Pacific Coast Stock Exchange, in private transactions, or in the over the counter market, at prices related to the then current price of the shares on said Exchange.

Industrial Instrument Corp., Austin, Tex., engaged in the manufacture and sale of various types of instruments used to measure and control the flow, level, pressure and temperature of liquids and gases and various types of pneumatic and electrical transmitting systems used to communicate measurement information. Offering is 60,000 shares of 6% Second Series Cumulative Convertible Preferred Stock, $10 par, for subscription by holders of the company's outstanding common and first series preferred stock on the basis of one new share of preferred for each eight shares of common and for each one share of preferred stock held; record date, subscription price, underwriter and underwriting terms to be supplied by amendment. Proceeds will be used to purchase machine tools, pay bank notes, pay accounts payable, pay notes to others, and the balance added to general funds to be used as working capital to finance work in progress and to carry accounts receivable.

Beryllium Manufacturing Corp., Valley Stream, N. Y., engaged in the machining and fabrication of pure beryllium components, as well as other metals, non-metals, plastics and phenolics. Offering is 105,000 shares of common stock for public sale at $4.50 per share. Proceeds will be used in expansion of plant and facilities, for beryllium inventory, and the balance for working capital.

Coleman Engineering Company, Inc., Los Angeles, Calif., engaged primarily in research and engineering work and in the design, development, manufacture and sale of missile ground handling equipment, electro-mechanical parts, products and systems. The company seeks to participate in production contracts to as large an extent as its facilities permit so as to balance income between engineering and manufacturing work and to maintain a wider basis for its income sources. Offering is 150,000



...with components by Rantec

Over the past years, Rantec has concentrated a major part of its research and development efforts in the design and development of components and subsystems for telemetry. Rantec is now able to offer the design engineer near complete systems in today's 225-300 Mc and tomorrow's 1700-2300 Mc bands. Here are components of amazing adaptability for the design of Rantec-reliable telemetry systems.

FOR THE 225-300 MC SYSTEM *Antennas and arrays, for manual tracking and simultaneous lobing... Helical arrays... dipole diversity reception arrays or feeds for large reflectors... these antennas have been used successfully in DISCOVERER, EXPLORER, PIONEER and ECHO projects... Antenna pedestals and servo mounts Telemetry multiplexers... units which combine two to six transmitters into one antenna... long term, hermetically sealed for outer space environment. Units are used in TITAN, POLARIS, MERCURY, DISCOVERER, SUBROC, X-15 and other projects*

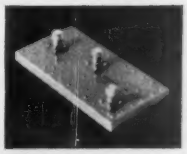
FOR THE 1700-2300 MC SYSTEM *Simultaneous lobing and electronic conical scanning antennas... Horn arrays and slot arrays Feeds for 6' to 85' diameter reflectors... used around the world Filters... coaxial and stripline... designed for rugged ground and space environments... Multiplexers... two to ten channel applications Hybrid assemblies... to be used with simultaneous lobing systems to permit tracking by providing sum and difference channel outputs Dual channel rotary joints... Control and display panels... Y-circulators... broad-band, compact... for use with parametric amplifiers... Coaxial isolators... ferrite switches*

2 CHANNEL MULTIPLEXER

TRANSMITTING-TRACKING FEED FOR 85' DISH

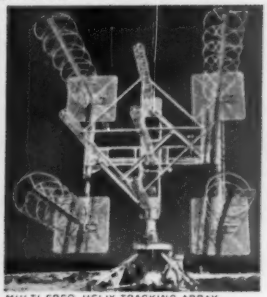
6 CHANNEL MULTIPLEXER

CUP-DIPOLE

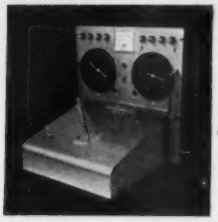

STRIPLINE DIPLEXING FILTER

ROTARY JOINT

LOW-LOSS, 3-CHANNEL MULTIPLEXER


MULTI-FREQ. HELIX TRACKING ARRAY

FERRITE SWITCH


ANTENNA CONTROL CONSOLE

Complete specifications for each component and subsystem are available. Rantec engineers will be happy to work with your telemetry team in the application of these components to the total system.

Rantec Corporation, Calabasas, California

rantec

shares of common stock for public sale on an all or none basis; offering price and underwriting terms to be supplied by amendment. Proceeds will be used to retire short term borrowings from a California bank, to retire other short term borrowings, and the balance for working capital and general corporate purposes.

Talley Industries, Inc., Mesa, Ariz.; the company does not conduct any operations but owns all the outstanding stock of Talley Industries (design, manufacture and sale of solid propellant ballistic devices), Astro-Rocket, Inc., (design, manufacture and sale of solid propellants for use in rockets and ballistic devices), Microtech, Inc., (design, manufacture and sale of waveguide and other microwave components), and has a large majority interest in Microwave Dynamics Corp. (manufacture of specialized microwave components and electronic test systems). Offering is $1,500,000 of convertible subordinated debentures due 1976, for public sale; interest rate, public offering price, and underwriting terms to be supplied by amendment. Of the proceeds, the company proposes to advance $150,000 to Microwave Dynamics to prepay secured bank indebtedness; $150,000 to Astro-Rocket for expansion of its propellant manufacturing facilities; $225,000 to Microtech to prepay indebtedness; $150,000 to purchase equipment for the expansion of microwave operations; the balance will be added to the general funds of the company to be advanced to subsidiaries for use as general working capital.

Filtors, Inc., Port Washington, N. Y., engaged primarily in the design, manufacture and sale of subminiature and microminiature hermetically sealed relays of a variety of types. Through its Seal-A-Metic Co. division, acquired in December, 1960, the company also designs, manufactures and sells glass-to-metal seals used in hermetically sealed transistors, relays and similar products. Offering is 271,000 shares of common stock for public sale at $7 per share; 122,000 shares for sale by the company and 149,000 outstanding shares by the present holders thereof. Proceeds from the company's sale will be added to general funds and will be available for general corporate purposes, including increased working capital. The company proposes to purchase land in Huntington, N. Y., and to invest in additional equipment and the carrying of larger inventories for the Seal-A-Metic Co. division; additional working capital will also be available to meet the expenses to be incurred in constructing and equipping a proposed new plant in Huntington.

THE U.S. ARMY H-23F.....A TOP PERFORMER FOR TODAY'S MOST

The H-23F answers the challenge of the military for a helicopter of the most modern capability...within budget limitations, and without increasing logistic support requirements. Fully developed and already in commercial service, this proven four-place helicopter is rolling off the Hiller production line...available immediately to fulfill special high performance requirements. It is ready also in a modification kit to convert operational H-23D Ravens into the higher powered, larger configuration.

Behind the H-23F are the military investors who fostered the H-23D. Their initial investment in growth-planned components has brought forth a line of power-packed helicopters which are a dividend on shrewd development strategy: new helicopters for the military without new development and tooling costs. *Latest, most advanced of these, the H-23F is ready now to report for duty.*

Military growth-planning of helicopters has been a necessity—calling for the shrewdest investment of all: military-industry cooperation, professionalism... and experience.

DEMANDING MILITARY MISSIONS... FULLY DEVELOPED... READY NOW!

H-23D RAVEN: *First helicopter ever granted 1,000 flight hours between overhauls by U.S. Army... maintenance hours half the all-Army average... lowest-cost-per-flight hour of any copter.*

12 E: *Next in the Hiller growth-planned line with the same dynamic components as the H-23D Raven, stepped up in hp and performance... No. 1 buy in the fiercely competitive commercial field... the ship that led the way for light helicopter use in 5 major industries.*

E4: *The next step upward in power — size — and Hiller's traditional long-range total economy... lowest cost 4-place copter in the air today, both in initial and operating cost.*

SUPER E: *And another step forward... the new E lifts altitude performance to 17,600 ft. at full gross... the most powerful helicopter in the light utility class and leader in flight and landing-load safety factors.*

H-23F: *Another military dividend from a growth-planned line... the only U.S. rotorcraft in its class with power to climb straight up fully loaded and at 820 fpm... ready, here and now for immediate, high performance missions.*

Designs are one thing. Deliveries another. Both come from

HILLER
AIRCRAFT CORP.
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SUBSIDIARY OF THE ELECTRIC AUTOLITE COMPANY

Indecision Bogs Communication Satellites

By Philip J. Klass

Washington—There is growing industry concern that indecision and uncertainty in government agencies over national policy on commercial communication satellites may enable the Soviets to score another dramatic space first.

The policy question admittedly is complex. Simply stated, it is: Assuming that there is economic justification only for a single space communications system, should American Telephone & Telegraph Co., which says it is anxious to proceed with such a system, be denied the necessary authorization in favor of an independent "common carrier's carrier," such as the one proposed by Lockheed (AW Mar. 20, p. 28)?

There would be no problem were it not that the several hundred million dollars required for such a system, coupled with the limited radio spectrum available, strongly suggest that only one system can be justified, at least in the immediate future.

Because a commercial space communication system is likely to be the first private venture in space, and thus establish a broad precedent for other commercial space efforts, officials are all the more reluctant to make hasty decisions.

Many Agencies Involved

The situation is not helped by the multitude of agencies that have a direct or indirect stake in such matters. The National Aeronautics and Space Administration, an agency of the executive department, is responsible for fostering peaceful uses of space, while the Federal Communications Commission, an independent agency created by Congress in 1934, is responsible for regulating all communication common carriers and allocating radio frequencies to all civilian users.

Because of international treaties and negotiations involved in establishing a space communication system, the State Department enters the picture, as does the Defense Department, which leases many commercial communication circuits wherever they are available and suitable for its own needs.

The Justice Department also is interested in any decision made to be sure that it conforms to anti-trust laws.

Representatives of all of these agencies, except perhaps for Justice, are expected to testify at hearings on commercial space communication systems to be held by the House Committee on Science and Astronautics later this month or early in May.

Because of the complexity of the problem and the brevity of the hearings, however, they may raise far more questions than they answer. Many observers believe that the situation requires prompt action by President Kennedy, either in the form of a clear-cut statement of national policy or the establishment of a single focal point of authority to make the necessary determination.

The following examples highlight the indecision and uncertainty that are hindering speedy development and implementation of a space communication system:

In a memorandum of understanding, signed by officials of NASA and FCC Feb. 27, the two agencies publicly stated that the "earliest practicable realization of a commercially operable communication satellite is . . . [an] urgent national objective." Further, that "private enterprise should be encouraged to undertake development and utilization of satellite systems for public communication services."

But several weeks after this agreement was announced, NASA officials indicated that the agency had decided to postpone the offer made last October by Dr. Keith Glennan, NASA Administrator under the Eisenhower Administration, to provide, at cost, facilities for launching technically promising experimental communication satellites for private companies.

NASA officials say this is not a change of policy, but reflects the agency's belief that the cost and risk involved at present may be too great to be borne by industry. They suggest that industry should await the results of NASA's own Project Relay satellite tests, scheduled for launching a year from now.

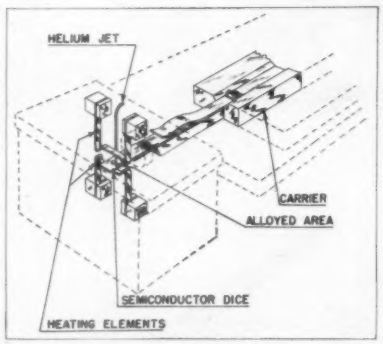
AT&T does not appear to share NASA's views about present costs and risks, judging from a statement made Mar. 22 by its president, Frederick R. Kappel: "We are already well along on developing an experimental satellite. What we need now is for some branch of the government to launch this so we can start testing. And we would be glad to pay for the rockets."

Glennan's Offer Accepted

Acting promptly on Glennan's October offer, AT&T applied for an FCC frequency allocation for an experimental satellite test, which was granted Jan. 19. The company also has held several meetings with NASA officials to discuss an arrangement whereby NASA would launch its satellite.

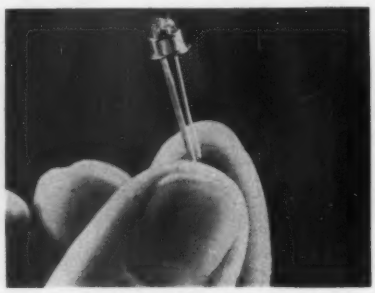
NASA representatives say that the AT&T offers were informal rather than specific, and that it has not yet received what it considers a firm proposal which is technically compatible with available boosters.

AVIATION WEEK has learned that on Dec. 14, AT&T's president wrote to Dr. Glennan proposing that NASA's Project Relay and AT&T's experimental satellite program be merged because of many common objectives. AT&T offered to build the satellite, which NASA



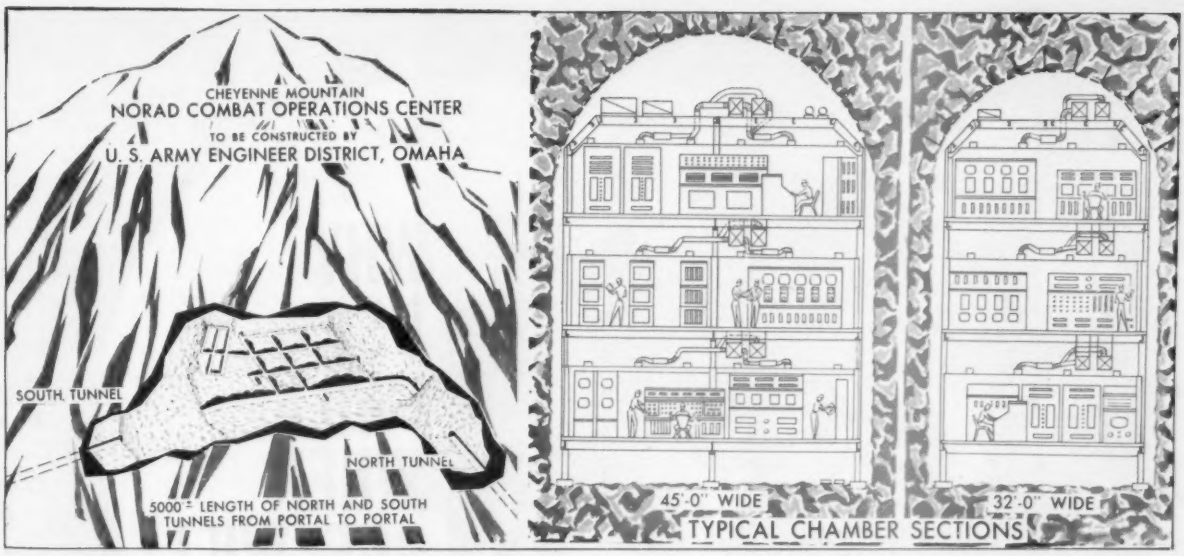
Alloying Furnace Used

New process uses small alloying furnace in which each semiconductor dice can be precisely positioned with heat source, replacing former batch process which lacked uniformity. Accurate measurement of diode voltage and the beta of each transistor can be performed during manufacturing process.



SPAT Availability

New silicon precision alloy transistor (SPAT), now available in eight medium-frequency silicon units, employs novel manufacturing process which greatly improves product uniformity and reliability, according to Philco Corp., which developed technique. Transistors feature high beta and very low saturation voltage, Philco reports.



Norad Operations Center to Be Built in Mountain

Norad combat operations center, to be built inside Cheyenne Mountain near Colorado Springs, is expected to withstand anything but a direct hit by a thermonuclear warhead. Scheduled to go into operation by early 1965, new facility will contain communications and situation displays and computers for aerospace defense. Two tunnels at 7,000 ft. contour will accommodate both pedestrian and vehicular traffic. Inside the mountain, three-story structures will be built in a series of intersecting chambers carved out of granite.

would launch. The company offered to bear the whole cost of both the satellite and the launching, or to share the costs in any way that NASA felt was proper.

When Glennan first disclosed NASA's plans to move into the active communication satellite field last fall, he had said that the agency's research and development effort would be aimed at "technological approaches which do not overlap military undertakings . . . and which do not duplicate private industrial developments which are aimed at commercial operations."

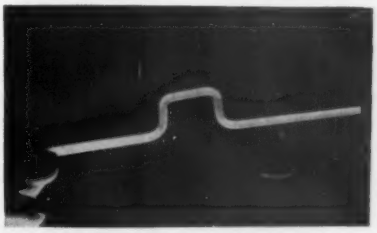
Some observers see the AT&T offer of Dec. 14 as an attempt by the company to "freeze out" any potential competitors from the space communications field who might get a toe-hold by winning the NASA Project Relay contract. Hughes Aircraft was actively pushing the development of a commercial communications satellite and had descussed its program with NASA (AW Dec. 12, p. 52). Lockheed and General Electric had systems studies under way, and others might be expected to join these ranks.

In the belief that acceptance of the AT&T offer, which would eliminate the planned competition for the Project Relay award, would not be proper, NASA did not accept the company's offer.

AT&T's Western Electric and Bell Telephone Laboratories team later submitted proposals for Project Relay and is one of seven bidders for the job. If the company is not selected for Project Relay, NASA will be willing to continue earlier discussions in an effort to work out a satisfactory program whereby the agency would launch an AT&T satellite, a NASA official told AVIATION WEEK.

But it is apparent that NASA is well aware of the implications of any agreements it reaches with AT&T. The agency has enough political problems already without risking charges of antitrust violations. The sensitivity of NASA officials to this problem was evident when a Justice Department letter to Lockheed was cited as an indication that the department would frown on having only one company in the space communications field.

The letter was in reply to a request from Lockheed for clearance to hold preliminary technical discussions with several other companies on the feasibility of setting up a combine which would establish a space communications system (AW Mar. 20, p. 28).



Fiber Optic Tube

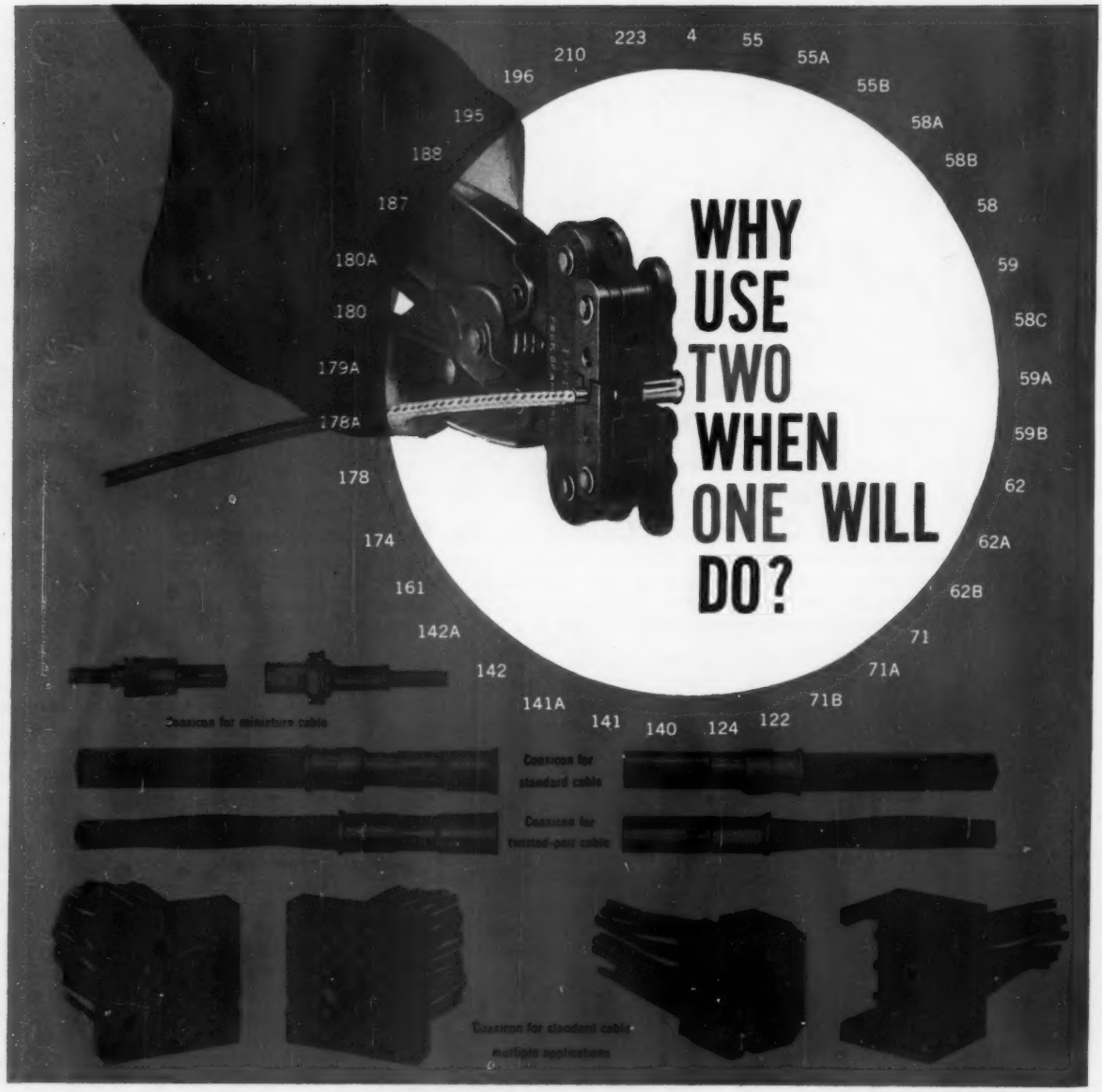
Fiber optic tube, built by Chicago Aerial Industries, demonstrates ability to conduct light around bends and curves without significant loss of light intensity. Company has recently received contracts for production of fiber optic components, from Avco Corp. and from Cummins-Chicago, intended for data readout applications.

The Justice Department letter said in part: ". . . we realize that the magnitude of such a project might make it difficult for a single company to carry on the necessary development work and that competitive considerations require that no one firm dominate satellite communications." The last part of the sentence is the portion that has been interpreted as Justice Department opposition to a single company in space communications.

However, the Justice Department official responsible for the letter says it was not meant to imply that the Justice Department would necessarily insist upon more than one company in the space communications field. The official points out that this issue was not raised in the original Lockheed request and that the department does not volunteer an opinion on issues that have not been raised. Although the department generally favors competition wherever it is feasible, there may be other, more important considerations..

The first official Justice Department appraisal of the legality of a solely or partially owned AT&T space communications system, or an independent "common-carrier's carrier" owned in whole or in part of using carriers and/or space hardware manufacturers such as Lockheed proposes, is not likely to come until after FCC receives replies from industry to its recently launched inquiry into the problems of regulating commercial space communications systems (AW Apr. 10, p. 34).

The commission asked respondents to specify in detail how they propose to



When you've got to attach a connector contact to the end of a coaxial wire, a single precise stroke of a crimping tool (one that crimps braid and inner conductor to the contact simultaneously) is the fastest way, the lowest-installed-cost way, the way that cuts human error in half . . . THE AMP WAY.

Our COAXICON® contact is designed on this principle: two strokes here is one too many!

COAXICON is a one-piece contact. It can be attached, simultaneously, with a single crimping tool stroke, to the braid and inner conductor of 37 sizes of RG/U coaxial cable up to ¼" O.D. (see size numbers above). And AMP makes the tools — hand and automatic — that control the crimp.

COAXICON consists of polarized, concentric male and female shells, made from drawn parts. The inner contacts, assembled in the shells, will attach equally to solid or stranded conductors. Where contact density is important, a miniature COAXICON fulfills the requirement.

COAXICON connectors will match cable impedances in the 50 100 ohm range, at frequencies as high as 150 megacycles. Impedance mis-match, incidentally, is only 1.06 to 1.09, even at 500 megacycles.

Write today for complete product information.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

own and operate a space communication system. In an unusual move, which reflects the complexity of the legal questions involved, the FCC also asked each respondent to indicate whether the plan proposed complies with existing regulations and anti-trust laws. If the proposed plan would require any changes in existing laws or regulations, these are to be detailed.

Industry comments are requested by May 1, but some observers believe it may require several additional months because of the considerable work involved.

FCC Regulation

At present, American Telephone & Telegraph Co. has a virtual monopoly on international telephone facilities, both radio and cable, terminating in the U. S.

However, rates and services are regulated by the FCC.

In the field of international telegraphy, there are four companies that now operate cables terminating in the U. S. and six American companies that operate point-to-point radio-telegraph circuits from the U. S. to foreign countries.

Because voice channels require approximately 20 times the bandwidth needed for telegraph and other record communications—a circuit capable of handling 20 telegraph messages can handle only one voice message—the bulk of intercontinental channels today are being used for voice communications. The percentage of channels devoted to voice can be expected to increase during the coming years because telephone traffic is growing at several times the rate of telegraph traffic—although not as fast as intercontinental telex (teletypewriter service).

The major elements of expense in a space communication system are largely independent of the number of channels (bandwidth) provided by the communication satellite itself. This means that it would cost nearly as much to put up a space communication system with the small number of channels needed solely for record communications as to put up one which also would handle telephone/voice.

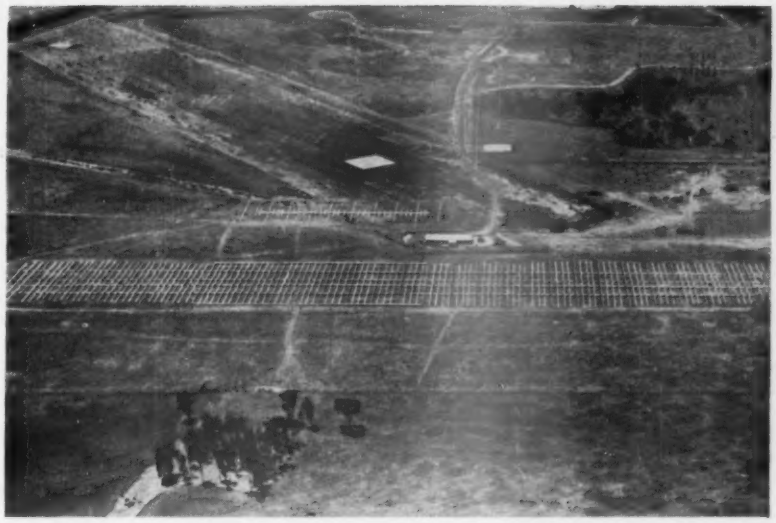
Conclusions Reached

Analysis of these and other factors lead most observers to the following conclusions:

- **AT&T will be the largest** single customer for a space communication system by the time the system becomes operational.
- **Without AT&T participation,** it is doubtful if all the other (record) carriers could justify the expense of a space communication system.
- **If an independent** (non-AT&T system) is authorized and placed in operation, and if AT&T does not receive authorization for its own system, it would be forced to join rather than forego economies expected from a space communication system.

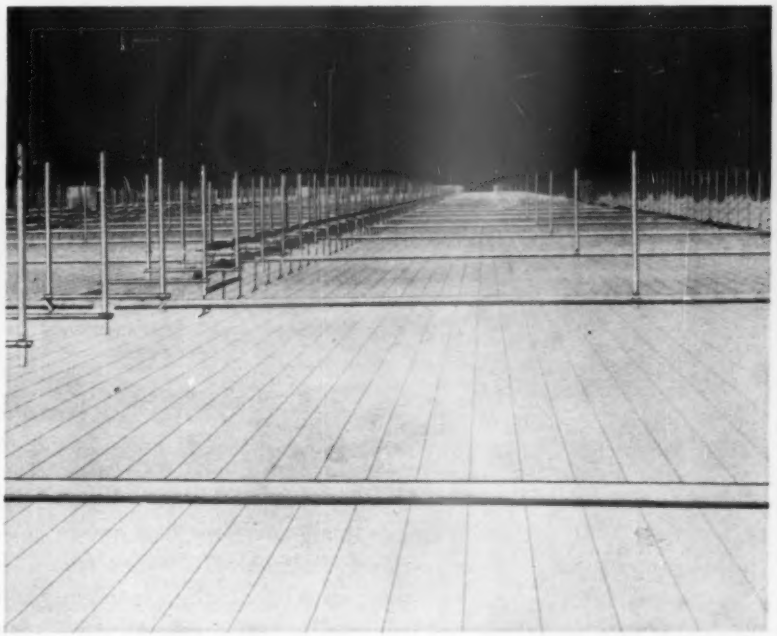
In a statement filed with the FCC Mar. 21, AT&T shows its awareness of objections raised to its proposed space communication system. The company said that the U. S. portion of the proposed system "would be made available to all international communication carriers serving the United States for any services they now are, or may in the future be, authorized to provide by the FCC under the Communications Act. The facilities would be made available on an equitable basis either by ownership participation through pro rata payment of capital investment and operating expenses or by lease arrangements."

Some observers speculate that this latest AT&T offer was sparked by the warm reception given the Lockheed pro-



Spasur Array in Operation

Space surveillance facility (Spasur) receiving antenna array, one of four now in operation across southern part of the U. S. for detecting all satellites including vehicles that do not transmit radio signals, is shown (above) in aerial view and as seen from ground (below). Array is 1,600 ft. long and 300 ft. wide. It receives energy bounced off satellite from high-power transmitter several hundred miles away. Spasur, built and operated by the Navy, is part of North American Air Defense Command's space detection system.



"And as time
goes on,
'defense' becomes
less a matter
of courage,
*of panache,**
and more
and more
a matter of
preparation."

Clemenceau

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*bravado

posal by several of the international telegraph companies.

Rather than risk a long-drawn battle or impasse—which might stimulate the idea that the government should establish and finance the space communications system and rent its services to the common carriers, providing an entering wedge for government into the communications field—AT&T might decide to join the Lockheed combine. Lockheed officials recently made a presentation to AT&T officials, outlining details of their proposed arrangement.

Important Differences

There are, however, important differences in technical concept which also separate AT&T and Lockheed, although these are not necessarily irreconcilable. AT&T favors the use of many low-altitude satellites in random polar orbits, while Lockheed favors the use of three satellites in synchronous equatorial orbits.

The low-altitude, multi-satellite approach is favored by AT&T because it avoids the 0.6-sec. time delay and echoes which the company says are objectionable to voice circuit users, and because this approach uses proven techniques which could permit earlier system operation.

Lockheed favors the synchronous (24-hr.) satellite approach because it will prove more economical and more flexible, and it minimizes radio interference with other services. Lockheed says the synchronous satellite system will be "economically feasible by 1968-70 and technically feasible even sooner."

Other companies that have studied the problem have come up with other system configurations. For example, GE has proposed the use of low-altitude satellites in a non-synchronous equatorial orbit. Each approach has its advantages and its disadvantages.

Tests conducted by several organizations indicate that the 0.6-sec. time delay in a synchronous 24-hr. satellite is not objectionable, and General Telephone & Electronics is reported to have developed a successful echo suppression technique. However, it is generally agreed that although there appear to be no difficult problems involved in stabilizing a satellite in a synchronous equatorial orbit, until some experience is gained it can not be classed as a proven technique.

Pressing Demands

Faced with fast-growing intercontinental voice communication demands and the long time required to construct and lay a submarine cable, AT&T feels it cannot afford to risk delay by putting all its reliance on the synchronous orbit approach.

On the question of anti-trust laws, there is speculation that the Justice Department might frown on Lockheed's direct participation in the combine it has proposed. Previously, the Justice Department attempted to force AT&T to divest itself of Western Electric, its manufacturing subsidiary, and to buy competitively from outside suppliers. If Lockheed owned a major interest in the combine, the question might be raised whether other space vehicle manufacturers could compete on equal terms for combine business. A Lockheed spokesman says the company is willing to compete for such business and/or not participate as a part owner in the combine if this proves necessary to meet anti-trust laws.

Lockheed's principle interest in initiating the study by Booz Allen & Hamilton, which led to the present proposed space communication system combine, was to develop a non-military market for its space technology capabilities. Having served as a catalytic agent to spark the interest of communication common carriers, such as General Telephone & Electronics and RCA Communications, Lockheed appears willing to bow out if this were necessary to compete for satellite and launching business.

Request Expected

But barring such a Justice Department determination, observers expect Lockheed soon will submit a request to the FCC for authority to proceed with the development and implementation of a space communications system. The company's lawyers believe that the commission already has the authority to grant such a request. AT&T is expected to follow suit, perhaps even to beat Lockheed to the punch, unless the two companies work out a single joint venture, which would greatly simplify the FCC's decision.

Mounted Microcircuit Technique Developed

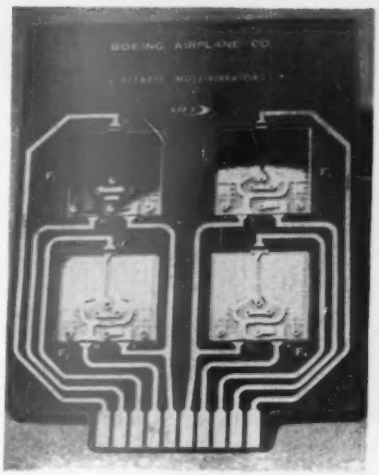
Goleta, Calif. — Straightforward method of mounting avionic microcircuits on a printed wiring card that plugs into standard connectors, permitting the use of microcircuits along with conventional card-mounted components in present equipment, has been developed by the Research Division of Servomechanisms, Inc.

The method is called the Planar-Inlaid technique because microcircuits are inlaid flush upon the phenolic card. This allows each microcircuit to be prepositioned and indexed. Microcircuits on each card are interconnected through photoetched conductors.

The Planar-Inlaid technique sidesteps the problem vexing many of the microcircuit packaging approaches, in which the microcircuits are stacked rather than laid alongside one another, of finding a reliable method of interconnecting subassemblies. This technique employs the conventional circuit card-to-connector connection.

Thus, the Planar-Inlaid technique trades some of the space and weight savings potential of microcircuitry for immediate application in existing equipment.

In a typical application four one-inch square, glass substrate microcircuits containing astable multivibrators are mounted on a 4¾ in. x 3½ in. plug-in card designed to fit into an Amphenol 143-010-02 10 pin connector.



MICROCIRCUITS, made for Boeing Airplane Co. by Servomechanisms, are mounted on phenolic plug-in circuit card which uses conventional connectors, permitting microcircuits to be used in existing equipment.

Self-Testing Rate Gyro

Self-testing rate gyro, Type GR-H4-T, contains built-in provisions to permit checkout of gyro motor speed, gimbal freedom and integrity of all circuitry. Permanent magnets in spin-rotor generate signal for speed check, while pick-offs permit test of gyro dynamics. Manufacturer: Northrop Corp., Nortronics Precision Products Dept., Hawthorne, Calif.

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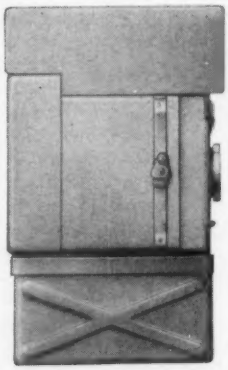

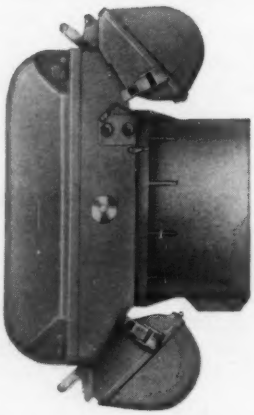

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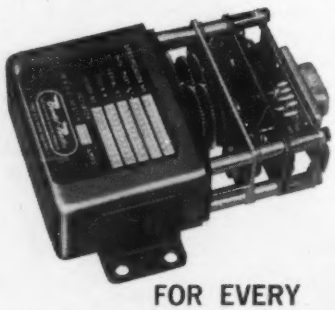

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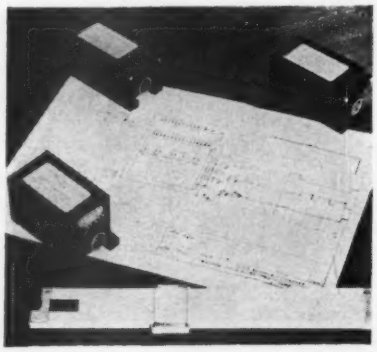
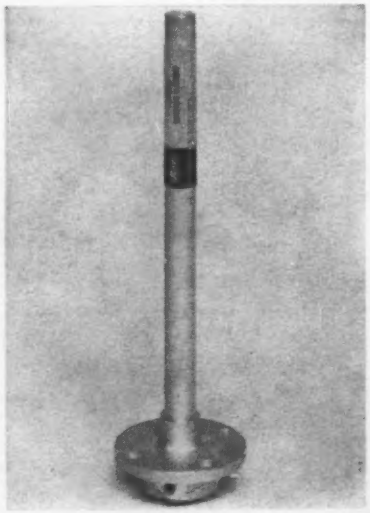
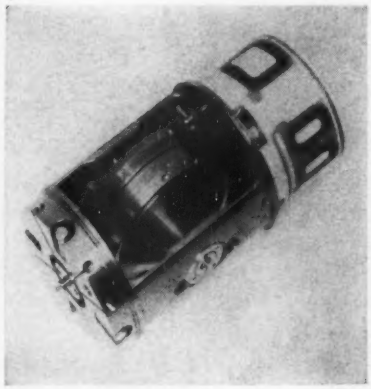


three distinct time sequences, weighs 13 oz., occupies less than 10.6 cu. in. and consumes 1½ watts maximum at 28 v.d.c. Switch is automatically reset by application of vehicle power. Manufacturer: Donner Scientific Co., Concord, Calif.

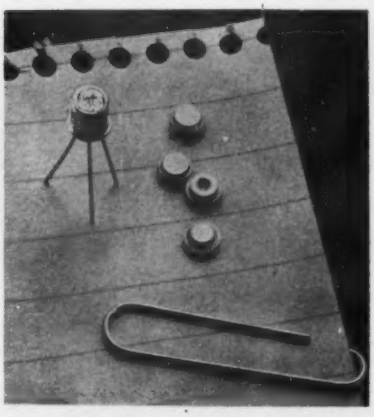


• **Vertical sensing element,** Type C70-1806-002, a gravity-sensitive, liquid-damped pendulous device uses a frictionless wire-suspended mass as the moving element of two orthogonally mounted differential transformers to provide a phase-sensitive output signal proportional to tilt angle. Sensor threshold is 1 sec. arc, output voltage is 150 mv. minimum at 30 sec. arc with a sensitivity of 20 mv. at 1 sec. arc. Damping factor is 0.7 to 1.0. Manufacturer: Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.

• **Miniature precision floated gyro,** Type SYG-1000, measuring 2.9 in. long x 1.83 in. dia. and weighing 0.95 lb., has random drift of 0.007 deg./hr. in azimuth position, 0.005 deg./hr. in vertical position in cogging test. Anisoelastic drift under steady acceleration is 0.01 deg./hr./G^2, and 0.005 deg./hr./G^2 under vibrating acceleration according to manufacturer. Angular momentum is 1.12 x 10^6 grm-cm^2/sec. Torquer and signal generator are combined in an integral unit. Gyro can be stored at temperatures from −85F to 185F and operated at temperatures as low as −65F. Manufacturer: Sperry Gyroscope Co., Great Neck, L. I., N. Y.



• **Microwave germanium tunnel diodes,** four new types for use at S-band frequencies, are housed in new miniature stripline packages. Type designations are: 1N3218, 1N3218A, 1N3219 and 1N3219A, with total capacities of 7, 4, 14 and 7 picofarads, respectively. Typical peak point current ratings of the first two are 1.0 ma., while the latter two have ratings of 2.2 ma., controlled within 10%. Typical inductance is 0.4 millimicrohenries, held to a maximum of 0.5 millimicrohenries. General Electric Co., Semiconductor Products Dept., Kelley Bldg., Liverpool, N. Y.



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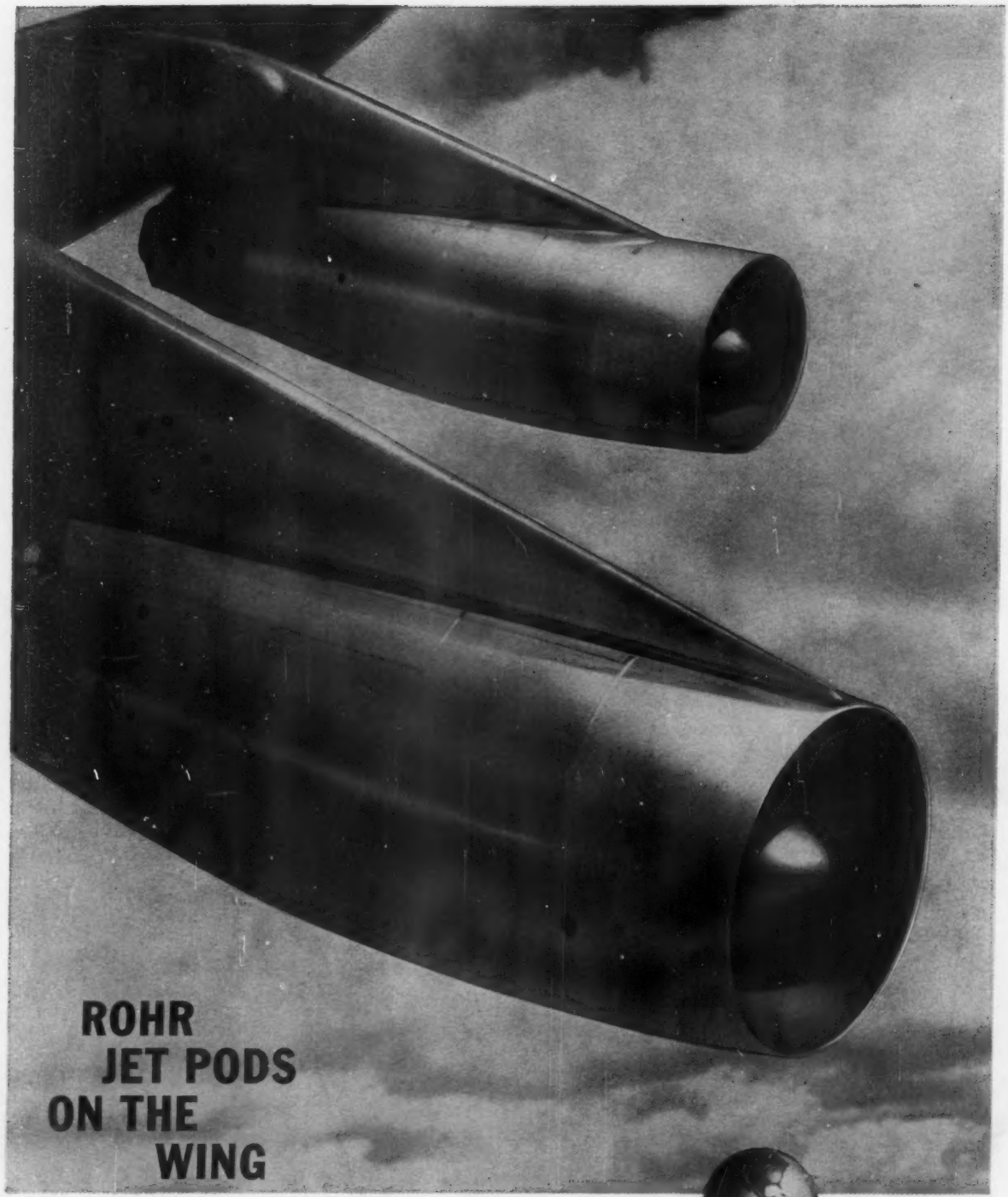

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Publications Received:

Accelerators—by Robert R. Wilson and Raphael Littauer. Doubleday & Co., Garden City, N. Y. $.95; 196 pp. paperbound. Semi-technical explanation of the machines of nuclear physics. Some of those discussed are Crockroft-Walton machines, Van de Graaf generators, cyclotrons, linear accelerators and various synchrotrons.

The Probable Cause . . .—by Robert J. Serling. Doubleday & Co., Garden City, N. Y. $3.95; 287 pp. Research on the history of various crashes and their causes. Discussion of the CAB, FAA, Air Line Pilots Assn. and the manufacturers' responsibilities for safe flying.

Flying Saucers and the U. S. Air Force—by Lt. Col. Lawrence J. Tacker, USAF. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. $3.50; 164 pp. The research and findings of the Air Force of unidentified flying objects. It explores the natural phenomena which have misled individuals, and the psychology that reinforces these delusions.

Aircraft Electrical Engineering—by H. Zeffert—George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.2. 90s. net.; 726 pp. (approx. $12.60). Aimed at surveying in detail all technical and installation problems encountered from beginning to end of project.

Men of Space—Vol. I—by Shirley Thomas. Chilton Co., Book Division, 56th and Chestnut Sts., Philadelphia 39, Pa. $3.95; 235 pp. Ten profiles, the first of a series, of Krafft A. Ehricke, Robert H. Goddard, Bernard A. Schriever, John Paul Stapp, Konstantin E. Tsiolkovsky, James A. Van Allen, Wernher von Braun, Theodore von Karman, John von Neumann, Charles Yeager. Illustrated.

Eliminating Man-Made Interference—by Jack Darr—Howard W. Sams & Co., Inc., 1720 E. 38th St., Indianapolis 6, Indiana. $2.95; 160 pp. Explains what man-made interference is, how it is transmitted and how it originates. Case histories are included along with how to minimize and eliminate interference.

Nondestructive Testing—by Warren J. McGonnagle—McGraw-Hill Book Co., Industrial and Business Book Information Service, 327 W. 41st St., New York 36, N. Y. $15.00; 457 pp. Treating nondestructive testing as a science, this book covers the physical principles, techniques, advantages, and limitations of various methods.

What the affiliation of Rochester Manufacturing Co. with American-Standard® means to you

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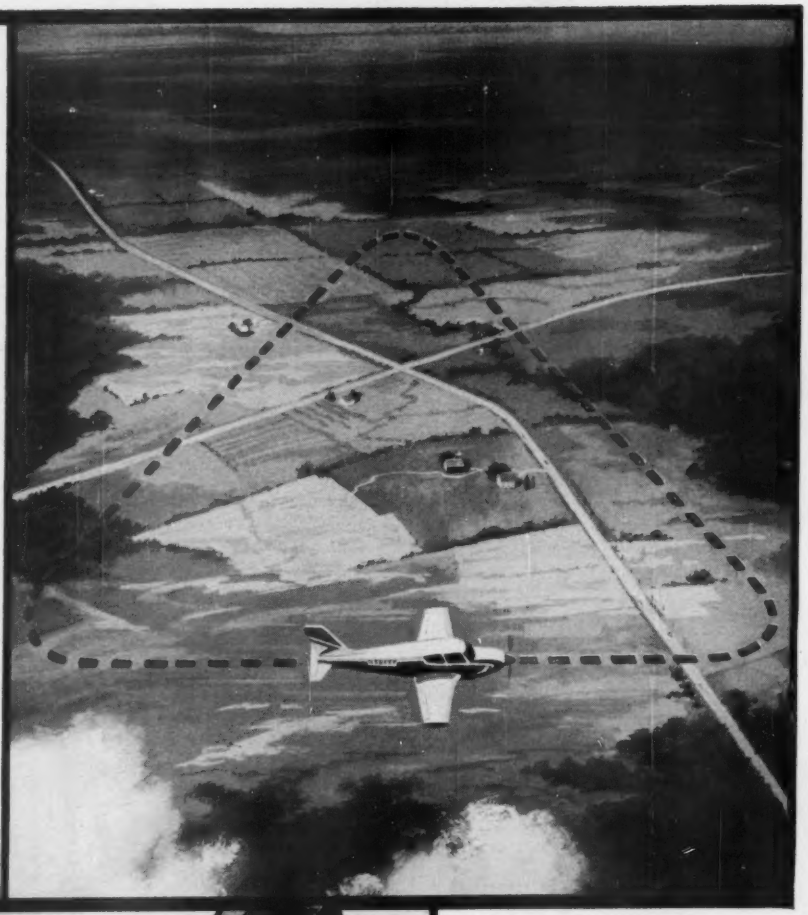

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SAAC 23 Jet Nears Metal-Cutting Stage

By Cecil Brownlow

St. Gallen, Switzerland—Final aerodynamic design modifications on the SAAC 23 six-to-eight passenger executive jet transport (AW Mar. 6, p. 87) are now being completed and initial cutting of metal for the first prototype is scheduled to get under way within the next few weeks.

New modifications in the twin-jet design, which already has gone through 23 configurations in efforts to boost performance and cut costs, include:

- **Extension of fuselage length** by approximately 20 in. in order to push the center of gravity to a point nearer the tail section for easier control of the aircraft. Extension increases the over-all fuselage length to 39 ft., 3 in.
- **Repositioning** of the two 2,400-lb.-thrust General Electric CJ610-2B engines located on either side of the fuselage by the same degree toward the tail section. New position will help in obtaining the desired center of gravity point as well as reduce cabin engine noise. In their altered position, the engine inlets will be 5 ft. behind the rear passenger bench.
- **Substitution of a fixed** stabilizer tail for the movable surface originally planned, primarily to reduce costs and operational complexities.
- **Incorporation of a ventral fin** along the fuselage beneath the tail section to minimize the possibility of a Dutch Roll maneuver during landing approach.
- **Considerable increase** in rudder size to boost response and ease of control.
- **Enlargement of nose wheel** size to conform with the main landing gear dimensions in order to achieve standardization and, thus, trim costs.

Swiss Designer

The modifications were jointly worked out by Dr. Hans L. Studer, designer of Switzerland's P. 16 close-support fighter built by Flug & Fahrzeugwerke, A. G., (FFA) and now director of the newly-formed Aviation Development Corp., and U. S. engineering consultant Gordon Israel.

Aviation Development Corp., with headquarters in St. Gallen, is the Swiss engineering subsidiary of Swiss American Aviation Corp., a U. S. firm formed by industrialist William P. Lear, Sr., specifically for the SAAC 23.

Israel, who collaborated with Lear on the Learstar conversion program and is a former Grumman Aircraft Engineering Corp. project design engineer, will work on the SAAC 23 project in Switzerland under contract through Federal Aviation Agency certification of the two prototypes that will precede the production models. Afterwards, according to Lear, he probably will oversee the final assembly and test flight operations of production models within the U.S. Under present plans, FFA will build the two prototypes at its Altenrhein facility near St. Gallen and then be responsible for producing the forward fuselage section and wings of the production models, if it has the available talent and facilities.

At the moment, the SAAC 23 is FFA's lone tangible product following the Swiss air force decision last spring against a P. 16 production order. It is tabbed, however, for a major share of Switzerland's planned licensed production of the Dassault Mirage III-C fighter and, because of this, does not want to sign a firm commitment for SAAC 23 production over a long haul.

If the Mirage program should grow to encompass all of FFA's available facilities and talent, Lear believes he can shift the jigs, plans, etc., for the forward fuselage section and wings to another European supplier without too much delay in the over-all program.

The rear fuselage section, according to Lear, probably will be fabricated in England. Other European production will be spread among companies in Italy, France, Germany and Spain. For the landing gear, Lear already has decided upon Japan's Mitsubishi Heavy Industries, which will build the assembly to SAAC specifications with tooling designed by Aviation Development Corp.

All master tooling, in fact, is being designed at St. Gallen under the aegis of Studer and Israel, and detailed plans will be supplied to the components' manufacturers.

Instrumentation for the aircraft will be supplied within the U.S. and, except for the two prototypes, purchased directly from the distributor by the buyer who can make any selection he chooses.

Lear, however, believes that most will choose the basic instrumentation of the prototypes since this will be certificated with the aircraft "and the holes for it will already be there" and any changes would necessitate a supplemental certification plus added cost.

He estimates the retail cost of instrumentation for each of the two prototypes at $60,000, including dual ADF and dual VHF navigation and ILS equipment, with a single VHF transceiver and a spare or auxiliary VHF transmitter.

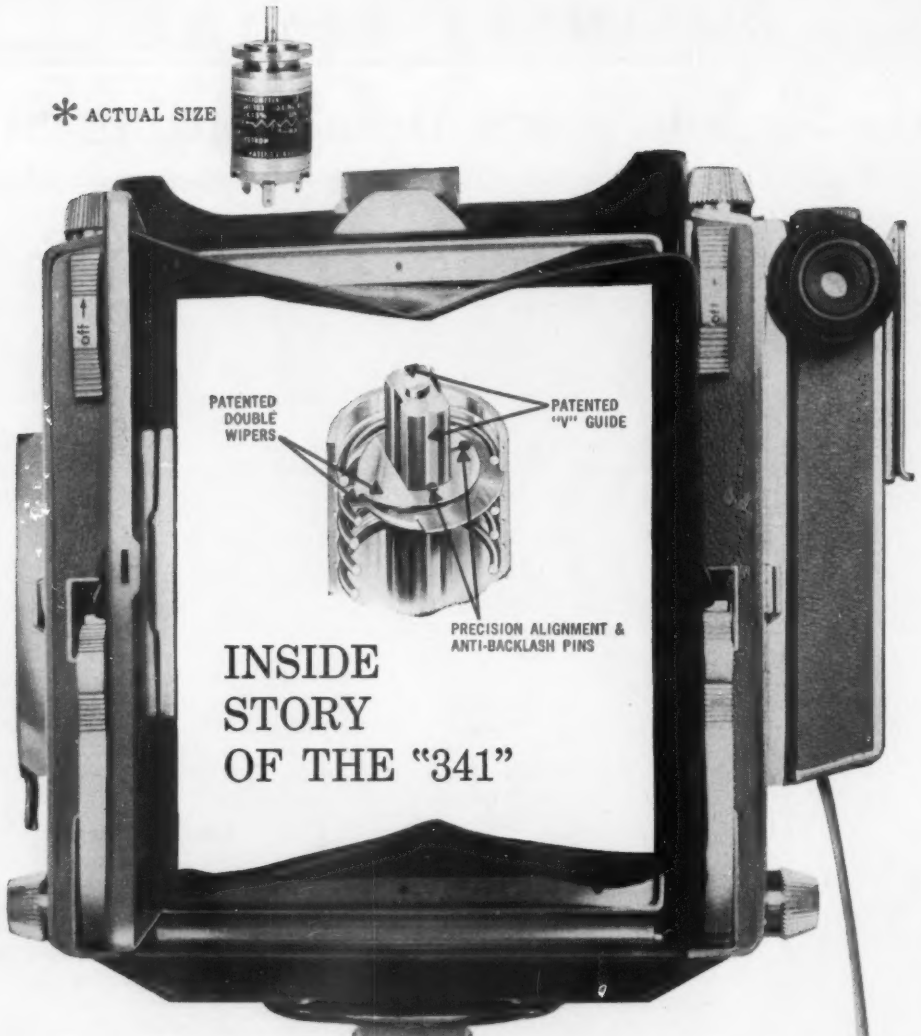
Exterior Antennas

Exterior antennas for the ADF, which will be built into the airframe, will be similar to the Motorola goniometer slabs; those for the VHF receivers will resemble Collins combination transmitting and receiving high speed designs, according to Lear. Provisions also will be made available for two sense antennas and a single glide slope antenna.

SAAC is bidding on the open mar-

First Shinn 2150A Lightplane in Production

Rollout ceremony of the first Shinn 2150A lightplane, formerly the Morrisey 2150 (AW Feb. 8, 1960, p. 99), is scheduled for May 1 at Shinn Engineering, Inc.'s Santa Ana, Calif., production facility. Plane sells for $8,950 flyaway factory. Gross weight is 1,817 lb. and the powerplant is a Lycoming O-320-A1A developing 150 hp. Cruise speed is 135 mph. Production is scheduled for one aircraft per 8-hr. shift or 22 units per month.



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First Three Hiller E4 'Station Wagons' Sold

First three commercial versions of the Hiller 12E helicopter, the E4 "Station Wagon," have been sold to George M. Brewster & Son, Inc., Bogota, N. J.; Puerto Rico Water Resources Authority, San Juan, P. R., and Yacimientos Petroliferos Fiscales (YPF), Argentina. Aircraft is available from Hiller production line, or as kit transforming the three-place 12E to a four-place E4 configuration (AW Aug. I, 1960, p. 85).

ket for the instrumentation, either as a package or as individual units, and Lear recently sent a letter to major U.S. avionics manufacturers requesting estimates. One recipient was Lear, Inc., of which Lear is chairman of the board, and he insists that it will have to compete on equal terms with other U.S. firms on the basis of reliability, cost and adaptability to SAAC 23 requirements.

All display instruments will be located on the control panel. "I've ruled out overhead instrumentation," Lear says, "until pilots come fitted with holes and knobs in their heads that fit the knobs and switches above them."

To enable the aircraft to be operated by a single pilot—although facilities for a co-pilot will be included—Lear wants to group the major part of the panel instrumentation in the center section. Here, room is provided for three 3¼-in. instruments located horizontally and another three of the same size located vertically.

Nose Section

One of the earlier modifications was a decision not to pressurize the nose section, although the remainder of the aircraft will be pressurized to operate to altitudes of up to 40,000 ft., and instrumentation located here, including a 12-in. radar scanner, must be capable of withstanding a temperature range from minus 40C to plus 125C.

In his letter to the equipment manufacturers, Lear declared that "the installation would have to be completely engineered and installed by yourself not later than Feb. 28, 1962, and preliminary approval of the equipment and installation would have to be accepted by us not later than May 15, 1961."

General Electric CJ610-2B powerplants will be purchased by the customer rather than directly from SAAC, but their $80,000 cost per aircraft is incorporated into Lear's hoped-for retail price of $250,000 per stripped-down plane. Basic model also will include the cabin pressurization system, engine instruments, electrical system, airspeed indicator, pitot tube and gear flap (for actuating landing gear) and speed flap controls.

Plane Cost

With the $250,000 for a basic plane, plus $60,000 for instrumentation and another $15,000 for interior decoration, Lear estimates that a purchaser should be able to buy a fully equipped plane for $325,000.

"After scouring the market from one end to the other," Lear says he has "pretty definitely" decided on the CJ610 as the best available powerplant for his purposes and that General Electric is now working closely with SAAC "modifying the engine so that it will be exactly adopted to our aircraft."

"We want," he adds, "the lowest possible fuel consumption at cruise, so GE is modifying the engine so that it has slightly less takeoff thrust but greater economy at cruise." Range of the aircraft with tip tanks, also standard equipment, will be slightly over 2,000 mi., and Lear says he plans to guarantee a Mach .73 speed, "but we're designing for Mach .8."

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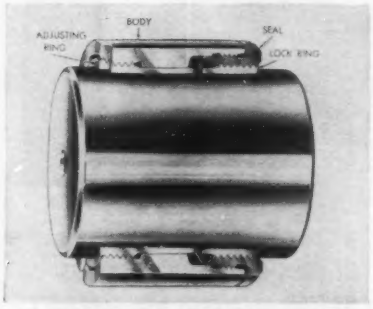

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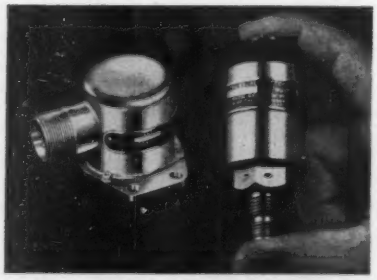

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and General Electric also are working towards perfecting a thrust reverser for the powerplant that will be capable of full modulation in flight. Lear is insisting upon the latter capability in order to control descent speeds to "within one knot." If such a reverser does become available, it probably will be offered as optional equipment on aircraft delivered in 1964, the second planned year of full production, at an estimated additional cost of $15,000 per plane.

Military Potential

Lear, who believes the potential military market for the aircraft outstrips by far its civil possibilities, also has discussed the possibility of an afterburner for the engine with Snecma in France.

Interior of the aircraft will be slightly cramped but not crowded, if the rough mockup at Altenrhein provides an adequate criterion for judgment. "We had to decide between roominess and speed," Lear says. "We chose speed because we think that that's what an executive aircraft needs. . . . A man can't stand up in his Cadillac."

Maximum cabin height of the SAAC 23 is about 67 in.; maximum width, 63 in.

Lear backs up his argument that a stand-up cabin is not necessary if speed is available by citing the type of flights most often made by executive aircraft. To support this thesis, he quotes from a University of Utah survey which, he says, shows that 30% of the corporate flights within the U. S. are under 400 mi., 80% under 800 mi. and 90% under 1,000 mi.

The survey also shows, according to Lear, that about 45% of the flights carry three persons or less and 80% four persons or less.

So far as the SAAC 23 is concerned, Lear says it is designed to carry six passengers "very comfortably," seven passengers "fairly comfortably" and a high-density eight passengers on flights of "about an hour" without becoming unduly uncomfortable.

Seating Arrangement

Seating arrangement envisages a rear seat for a maximum of three persons, an aft-facing bench behind the pilots' compartment and a side seat. And, although there is only one large window on either side of the passenger compartment, the mockup indicates that all passengers should have a relatively good view to the outside.

Pilots' compartment will be fitted with a wrap-around windshield produced in two main sections that provides better-than-adequate forward and side visibility. Entrance to the passenger compartment will be gained through a two-piece door, with the lower section folding down into a stairway.

The wings, with a 12-deg. sweep, have a span of 34 ft., 5.4 in. Fuselage is area ruled, and the two refueling points for wing and tip tanks will be located on either tip tank. Lear decided against a central refueling point because of cost and "because I don't think enough airports will have the necessary pressure refueling systems for this within the next few years."

Luggage space behind the passenger compartment should be ample with room enough to carry an estimated 50 lb. per person.

Lear hopes to roll out his first prototype in March, 1962, have it certificated by summer and begin demonstration flights in the U.S. before the end of the year, offering initial deliveries to customers in 1963.

Production Rate

Planned production rate, Lear says, is "at least" 75 aircraft in 1963, 100 in 1964, 125 in 1965, 150 in 1966, then leveling off to between 175 and 200 in 1967 and subsequent years.

Market plans call for the airframe components of production models to be shipped from Europe and Japan to a single U.S. assembly point, most likely an existing facility that will work for SAAC under contract. SAAC, however, will retain control over assembly and quality control through a team of engineers and flight acceptance pilots.

Once the aircraft has been accepted, it will be fitted with a portable instrument package and flown to the distributor. There, the instrument pack-

VHF Remote Unit

Gables Engineering, Inc., Coral Gables, Fla., has developed a remote control VHF or HF radio frequency selector for light aircraft, with the faceplate about the size of a package of cigarettes—2⅞ in. x 2⅞ in. Space required behind panel ranges from 2¾ in. to 5¼ in. in depth. Entire assembly is internally lighted.

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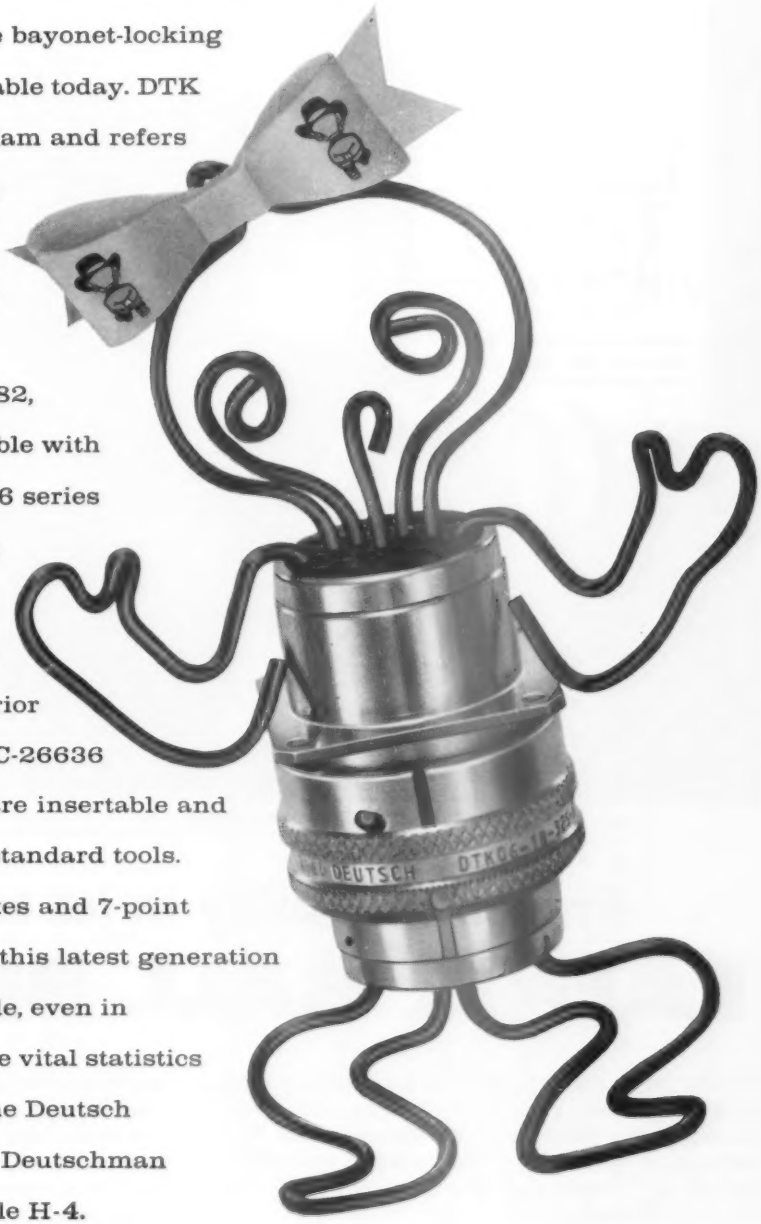

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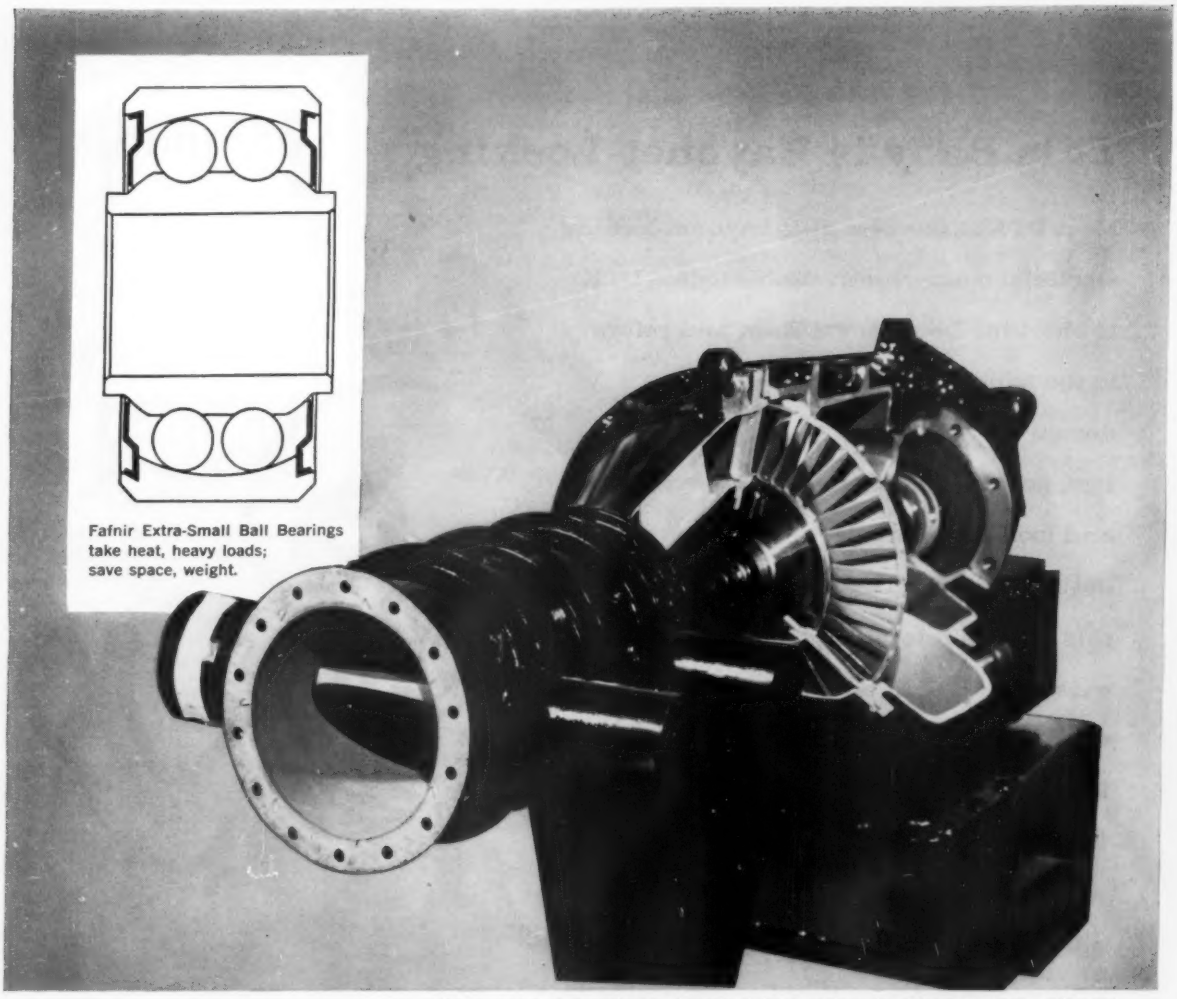

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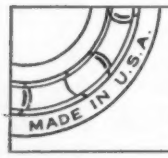

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The same depth of imagination and technical daring is now at work modifying and adapting this sophisticated machine for a variety of civilian and military space missions. Dozens of specialized orbiting and inter-planetary vehicles will depend upon the power of Atlas to thrust them into space.

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Technical openings also exist in other specialties. Write Mr. R. M. Smith, Industrial Relations Administrator - Engineering, Dept. 130-90, Convair Astronautics, 5658 Kearny Villa Road, San Diego 12, California. (If you live in the New York area, please contact Mr. J. J. Tannone, Jr., manager of our New York placement office, CIrcle 5-5034.)

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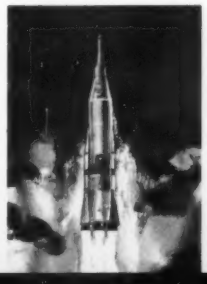

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age will be removed and returned to the assembly point, and the distributor will take over responsibility for final instrumentation.

Quantity Sales

Lear is betting on low airframe cost and relatively low cost of the finished product to spur quantity sales. And, at his price, he must have quantity. Estimated breakeven point for SAAC on the project is 400 aircraft.

To hold down the purchase price—Lear concedes that "there are people willing to bet I won't make it"—he is cutting individual profits to SAAC and the distributors to a minimum, "but the distributor will get all the instrument profits and come out better in the end."

SAAC is Lear's own firm, completely independent of Lear, Inc., which its board chairman says is "not psychologically equipped" to get into the field of aircraft development since "it's in the equipment business." He estimates that he will spend "between $2.5 million and $3 million" before the SAAC 23 is fully developed.

He believes, however, that the aircraft will go well beyond the breakeven point and already is seeking new projects in order to keep SAAC and Aviation Development Corp. going concerns well beyond the production span of the SAAC 23.

Italian Plane to Be Assembled Here

Southwest Airmotive, Dallas, Tex., has contracted to assemble the Italian Nardi four-place FN-333 all-metal amphibian Riviera. First demonstrator will be shown throughout the U.S. early this year.

Built by SIAI-Marchetti, Italy, the Riviera fuselage, wing and tail section will be shipped to Dallas where Southwest Airmotive will assemble these components with the 240-hp. Continental IO-470-P engine and Hartzell constant speed pusher propeller, instruments, and other accessories as ordered.

The first prototype of the Riviera FN-333 was flight tested by Nardi in 1952 (AW Jan. 5, 1953) with a 225-hp. Continental engine and hydraulically folding wings. In 1956 Fiat announced plans to produce four prototypes (AW Sept. 10, 1956) to speed development of the project. The new version, to be imported into the U.S. by Lane Aircraft of Dallas, features a lighter and stronger retractable tricycle undercarriage with steerable front wheels. Lateral floats and water rudder are also retractable.

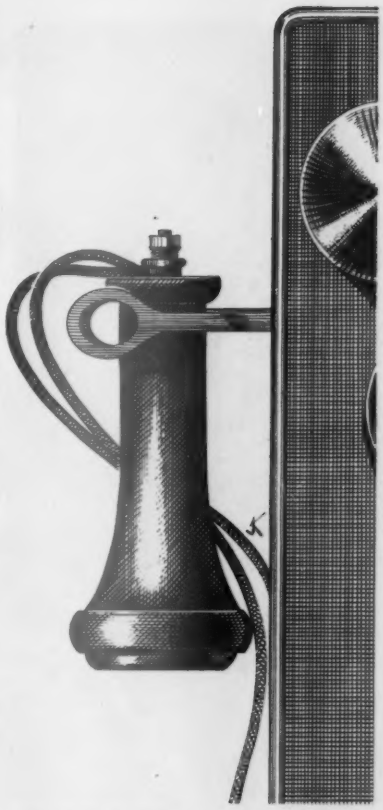
Aircraft will be marketed through direct dealers in the U.S., Canada and Mexico along with factory-recommended stocks of spare airframe parts.

Contract for the assembly by Southwest Airmotive was signed in a November meeting between Gerald L. Spear, Lane Aircraft executive vice president; J. E. Lockart, Jr., Southwest Airmotive vice president and Dr. Italo Franzetti, president and Alessandro Breno, chief engineer, both of SIAI-Marchetti, Milan, Italy.

FN-333 Riviera

Wing span	34 ft.
Length	23.99 ft.
Empty weight	1,962 lb.
Useful load	1,014 lb.
Gross weight	2,975 lb.
Wing area	163 sq. ft.
Wing loading	18 psf.
Normal fuel	39.6 gal.
Auxiliary fuel	15.6 gal.
Luggage space	15 cu. ft.
Maximum speed	180 mph.
Cruise speed (8,000 ft.)	165 mph.
Stall speed (with flaps)	65 mph.
Ceiling	20,000 ft.
Normal range	560 mi.
Maximum range	775 mi.
Price, basic	$35,000

RIVIERA fuselage, wing and tail section will be shipped from Italy to Dallas for assembly by Southwest Airmotive. Powerplant will be 240-hp. Continental IO-470-P.



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BCR-50 is a crystal controlled, all transistor, receiver-decoder operated by frequency modulated carrier signals in the 406-549 megacycle range. It provides 20 independent control channels with relay contact output. Each channel controls a SPST relay with contact rating of 2 amps at 32 VDC. Six channels, having a total deviation of ±120 Kc., may be used simultaneously. A 5 microvolt signal will energize 6 channels under normal environmental conditions. Input of 7.5 watts at 27.5 VDC with 6 channels actuated. Dimension: 7" high, 6⅞" wide, 8" long with mounting base. Weight: 9.5 lbs. BCR-50 is produced by Babcock, the world's foremost designer and manufacturer of remote control and guidance systems.

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GE Eyes CJ610, CF700 Executive Sales

By Andy Keil

Lynn, Mass.—General Electric is aiming its small lightweight commercial CF700-2B, CJ610-1 and CJ610-2B gas turbine engines toward a potential 1961-1970 market of from 1,000 to 1,500 turbine-powered executive aircraft in the 8,500-lb. to 14,500-lb. gross weight classification.

General Electric's Small Aircraft Engine Department (SAED) believes that the class of aircraft above the 4,000-lb. gross weight category will be turbojet- or fan-powered and that the conversion from piston power will be complete as soon as the price of the turbines can be reduced to within 15% of that of piston powerplants.

Price Is Key

General Electric says it has favorably priced turbines in the CF700-2B, CJ610-1 and CJ610-2B commercial derivatives of its military J85 turbojet—the first design details of which were published in AVIATION WEEK Apr. 11, 1960.

The J85 is presently powering the McDonnell GAM-72 Quail decoy missile, the Northrop T-38 Talon trainer and the Northrop N-156 supersonic fighter.

The 355-lb. CJ610-2B, with it high thrust/weight ratio of 8:1—a figure that General Electric says can increase to 11.5:1 within a year—is expected to power Lear's SAAC 23, Israel Aircraft Industries' B101C and Piaggio's twinjet executive aircraft, all of which are now in development (AW Mar. 6, p. 87).

The CJ610-1 will also power a new U.S.-built light-twin aircraft in the 12,500-lb. to 14,500-lb. gross weight category, planned by Aero Commander. General Electric is expected to order several of these aircraft for corporate use.

Future Production

"By 1970 General Electric expects to have produced about 2,000 small civil turbines," Gerhard Neumann, general manager of SAED at Lynn, Mass., said. Neumann says these engines can be applied to executive and utility aircraft, bomber-navigator-pilot trainers, VTOL/STOL cruise powerplants, large, long-range drones and light Navy/Marine attack aircraft.

"By the end of 1961," Neumann said, "GE expects to have shipped over 1,000 of the Mach 2 J85s." This engine has accumulated 22,000 hr. of test time to date, including 3,800 hr. in the air with the T-38, N-156 and CAM-72.

Federal Aviation Agency certification of the aft-fan CF700 and the turbojet CJ610s is expected in the third quarter of 1961. Initial overhaul time is expected to be 600 hr. with a growth potential to 1,000 hr. within the year. Two compressor rotors have passed 1,000-hr. test runs, with one CJ610 engine now completing the third consecutive 150-hr. military test of the MIL 5009-B Endurance Cycle Test Program. This engine was disassembled after 350 hr. and showed evidence only of some cracking of the combustion outer liner shell. Federal Aviation Agency development tests also are being conducted, including over-temperature (100 deg.), over-speed, 500-hr. power test and hailstone ingestion. A bird ingestion test is currently being contemplated.

All commercial engine testing has been company-funded with about $5 million spent to date.

General Electric has decided to amortize the development over a long period of time and will price the engines attractively for industry.

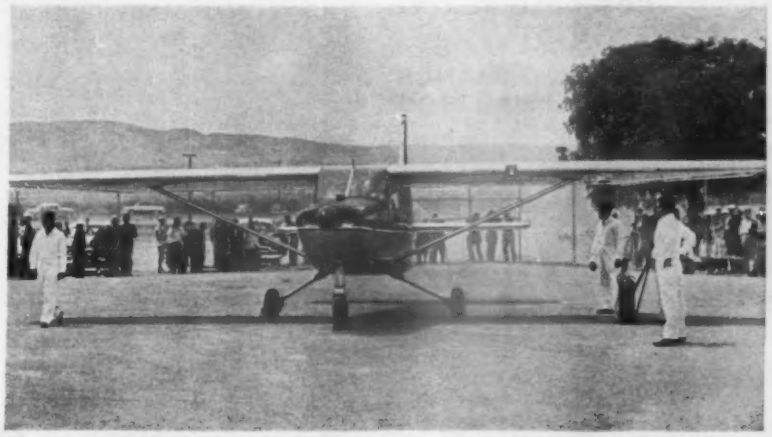
Civil Engines

Details of the civil versions of the J85 include:

• **Aft-fan CF700-2B** weighs 615 lb. and has an envelope size of 69 in. x 34 in. Price is $65,000 or $15.5 per lb. sea level thrust. With takeoff sea level thrust of 4,200 lb. and specific fuel consumption (sfc.) of .69, thrust is 900 lb. with sfc. .95 at an altitude of 36,089 ft. at Mach .776. This engine is designed for twin-engine corporate and utility transports in the 15,000-20,000-lb. class and for four-engine aircraft ranging in weight from 40,000 to 70,000 lb. Lockheed JetStar, North American Sabreliner and Grumman Gulfstream are aircraft included in the latter gross weight category. The aft-fan engine incorporates a fuel consumption advantage over comparable turbojets of 15 to 20%. With maximum rpm. of 8,600, the aft-fan follows the gas generator with a fraction-of-a-second lag. (Rotor rpm. of all three compact engines is 16,500.)

• **CJ610-1** weighs 355 lb. and has an envelope size, without gear box, of 42 in. ×17.7 in. Price is $45,000 or $15.8 per lb. sea level thrust. Takeoff sea level thrust is 2,850 lb. and sfc. is .99. Maximum continuous thrust is 2,700 lb. with an sfc. of .97. This engine is designed for aircraft weighing 12,500 to 14,500 lb. gross weight. Included in this category is the aircraft planned by Aero Commander to be ordered by General Electric.

• CJ610-2B, the derated version of the CJ610-1, is priced at $40,000 or $16.6 lb. sea level thrust and differs only from the -1 in its maximum continuous thrust of 2,400 lb. and sfc. of .90. It



Lockheed-Azcarate LASA 60 Flight Tested

Lockheed Aircraft Corp.'s first Mexican-made aircraft, the Aeroguayin LASA 60, was flight tested and its San Luis Potosi plant inaugurated recently. Lockheed-Azcarate is 51% Mexican-owned and the cost of constructing the San Luis Potosi plant was pegged at $2 million. The LASA 60 is Mexican made except for instrumentation and the 260-hp. Continental TS10-470-B engine. Maximum velocity of the aircraft is 167 mph., cruising speed 150 mph. and initial climb rate is 891 fpm. Service ceiling is 23,100 ft. over sea level with a guaranteed range of 550 mi. with full load. Maximum cargo rate is 1,256 lb. (AW Jan. 9, p. 115), and the plane can carry six persons plus 200 lb. of package. The plane will sell for $22,000-$24,000 in Mexico and will sell for $25,960 in the United States. The Mexican government has reportedly bought eight planes on trial.

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Engine Specifications

CF700-2B

Weight ..... 615 lb.
Dimensions ..... 69 in. x 34 in.
Thrust .... Takeoff (sea level) .. 4,200 lb. (sfc. .69)
Altitude (36,089 ft., Mach .776) .... 900 lb. (sfc. .95)
Gross weight category
Twin-engine aircraft . 15,000-20,000 lb.
Four-engine aircraft . 40,000-70,000 lb.
Aft-fan rpm. 8,600
Price $65,000

CJ610-1

Weight ..... 355 lb.
Dimensions (without gear box) ... 42 in. x 17.7 in.
Thrust .... Takeoff (sea level) .. 2,850 lb. (sfc. .99)
Maximum continuous . 2,700 lb. (sfc. .97)
Gross weight category . 12,500-14,500 lb.
Price $45,000

CJ610-2B

Weight ..... 355 lb.
Dimensions (without gear box) .. 42 in. x 17.7 in.
Thrust
Maximum continuous ..... 2,400 lb. (sfc. .90)
Gross weight category .. 8,500-11,000 lb.
Price $40,000
Rotor rpm. of all engines: 16,500.
FAA Type Certification, all engines: 3rd Quarter 1961.

is sized for relatively small aircraft down to 8,500 lb. gross weight and includes the SAAC 23, Israel B101C, and Piaggio's twin-jet executive transport.

Like the J85, the commercial engine is an axial-flow eight-stage compressor, two-turbine engine incorporating a through-flow annular-type combustion system constructed with a louvered shell for cooling. Perforations in the liner allow for thorough mixing and uniform temperature distribution. Twelve dual-orifice fuel nozzles provide a good spray pattern under full range of operating conditions.

Variable anti-ice inlet guide vanes and controlled interstage air bleed valves (bleeding from the third, fourth and fifth compressor stages) operate during starting and acceleration conditions.

Each rotor disk is connected to the adjoining disk and the drive of the rotor is transmitted from one disk to the other via close-tolerance studs, which is a break-away from the shaft-type construction. While the first-stage rotor blades are pinned, the rest are dove-tailed in a manner that avoids vibration and facilitates low-cost manufacture, according to General Electric. Stator vanes can be replaced in removable segments at one time.

The two-stage axial-flow turbine,

splined directly to the compressor shaft, is cooled by the compressor bleed air. The turbine blades are solid, incorporating a shank-type design which separates the turbine disk from the hot gas stream.

Inspection and maintenance is simplified by the horizontally-split casing of the compressor and turbine and two inspection ports in the combustion chamber.

PRIVATE LINES

Hartzog Aviation has been named Beech Aircraft Corp. distributor for 19 northeastern counties of Illinois, 47 southern and eastern counties of Wisconsin, 4 northwestern counties in Indiana and 12 northern peninsular counties in Michigan. President-General Manager Ira B. Hartzog was formerly general manager of Butler Airplane Sales, former Beech distributor for the area, which had attained a volume of $2 million in annual sales. Hartzog forecasts an eventual $5-million business volume for the area and plans to enlarge current personnel and facilities at his greater Rockford Airport, Ill., base. He plans to franchise at least five additional dealers in this territory.

Federal Aviation Agency is asking for cooperation from aircraft owners and operators in a new study on propeller fatigue failures. FAA requests that damaged propellers be turned in to the nearest FAA District Safety Office along with a brief maintenance and operation history of the airframe and engine in relation to propeller mishaps; a complete history of the propeller, including repairs, alterations and time in use; information and any instance of rough engine operation; and information relative to engine crankshaft dynamic damper condition. FAA Form ACA 1226 is available for reporting purposes.

Single-place sports helicopter has been built and ground-tested at Kirovograd, Ukraine, according to Tass. Designed by Yaroslav Gashulyak, the helicopter weighs some 200 kg., is three meters long, develops some 90 km. per hour in level flight and is powered by a motorcycle engine.

Teterboro Airport aircraft dealers held a consolidated static show of the new single- and twin-engine aircraft models April 8 and 9. Cooperating in this effort were Atlantic Aviation Corp., distributor of Beechcraft; Safair Flying Service, Inc., which handles the Piper line; Teterboro Aircraft Sales, Cessna; and Watson Aviation, Inc., distributor for Aero Commander, Mooney and Lake aircraft plus a number of aircraft accessory suppliers.

WET SPACEMAN ■ The Null-Gravity Simulator—developed by Lockheed/Georgia — rotates submerged spacemen up to 80 r.p.m. to create the effects of weightlessness. This device in the Human Factors Laboratory is just one of the diverse aerospace research and manufacturing capabilities at the Georgia Division.

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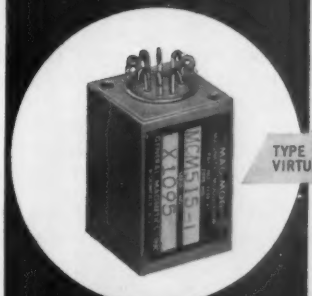

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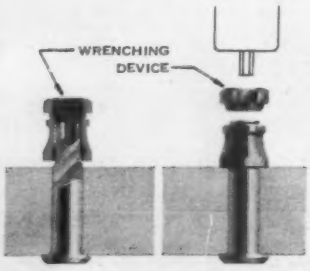
The Air Force's Mach 2 B-58, produced by the Convair Division of General Dynamics, packs maximum mission performance and flexibility into a minimum weight and space structure. The Hi-Lok Fastener is highly suitable to this advanced structural design and is used in a variety of conditions.

Used primarily in shear applications, the Hi-Lok provides a predetermined clamp-up or ultimate tensile value which is highly consistent with all other Hi-Loks in the same joint. Unlike a swaged type fastener, the Hi-Lok retains the same consistent tensile value in all grip conditions, minimum through maximum.

For open structural areas, Hi-Loks can be installed quietly by one man at rates up to 45 per minute using automatic installation tooling. In corrugated areas, Hi-Loks can be used without risk of damage to the adjacent structure because Hi-Lok tooling engages the fastener away from the bearing face. Where return flanges restrict access, the Hi-Lok offset, 90° and extended tooling provide the necessary reach.

Hi-Lok tooling is simple and inexpensive. It is comprised of adaptor tools fitted to standard, multi-purpose air drivers which may be found in any shop.

The wrenching device on the self-locking Hi-Lok collar shears off at the pre-established design torque level. Torque inspection after installation is not required.



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AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by Air Materiel Command Aeronautical Systems Center:

International Business Machines Corp., Federal Systems Div., New York, N. Y., various quantities of components of bombing navigational systems, type AN/ASB-9 (installations for B-52 aircraft) supplemental agreement No. 1 dated Nov. 29, 1960 to contract AF 33(600)41433, $118,582.

AiResearch Manufacturing Co., Phoenix, Ariz., gas turbine compressors, model GTC-85-56, iaw/contractor's model specification SC-5259B dated Aug. 8, 1960, FSN VH 2835-724-0088 (contractor's P/N 378374-1) spare parts and revisions to engineering data, supplemental agreement No. 2 dated Jan. 10, 1961, to contract AF 33(600)41877, 16 ea., $187,445.

Beech Aircraft Corp., Wichita, Kan., L-23F aircraft, spare parts, ground support equipment data (Army Liaison) contract AF 33(600)42222 dated Dec. 7, 1960, $467,927.

International Business Machines Corp., Federal Systems Div., Oswego, N. Y., various quantities of components of bombing navigational systems, type AN/ASB-9A (installations for B-52 aircraft) letter contract AF 33(600)42599 dated Dec. 19, 1960, $649,510.

Lear, Incorporated, gyroscope, rate, switching, type MO-1, contractor's P/N 134107-C1, FSN 6062-6615-618-9297, Aerno 60-5938, spare parts, ground support equipment and related data (installations for B-52H, B-58A, F-105D, C-130B, SC-130B, KC-135A, T-38A, T-39A, TB-38A and HU-1B aircraft; spares for B-58A, SC-130B, F-102 and F-100 aircraft) IFB 33-600-61-139, contract AF 33(600)42630 dated Feb. 7, 1961, 2263 ea., $1,019,031.

Olin Mathieson Chemical Corp., East Alton, Ill., cartridge, stores, ejector type ARD 446-1, iaw/contractor's specification OM-P-101 dated March 13, 1957, Aerno 93-0363, contract AF 33(600)42701 dated Jan. 27, 1961, 197,395 ea., $382,798.

Hughes Aircraft Co., Culver City, Calif., additional man days of installation support services for ASQ-25 aircraft weapons control system used on F-106B aircraft, supplemental agreement No. 20 dated Dec. 19, 1960, to contract AF 33(600)39405.

Lear, Incorporated, Grand Rapids, Mich., product improvement on the AF/A24G-1 control assy. and the DCK-10/A24G-1 third gimbal controller, contract AF 33(600)42164 dated Oct. 20, 1960, $546,201.

Lockheed Aircraft Corp., Burbank, Calif., F-104G aircraft mobile training unit, spare parts and ground support equipment, letter contract AF 33(600)42664 dated Jan. 11, 1961, $15,000,000.

Ampex Corp., Ampex Data Products Co., Redwood City, Calif., recorder/reproducer, magnetic tape, portable, Ampex model CP-114 and maintenance manuals, IFB 33-600-61-134, contract AF 33(600)-42730 dated Jan. 12, 1961, 1 ea., $36,530.

Northrop Corp., Norair Div., Hawthorne, Calif., mobile training unit, designated T-38-8 (for T-38A support system) iaw/Norair training specification NTS-19 dated Oct. 17, 1960, amendment No. 2 dated Jan. 6, 1960, to letter contract AF 33(600)41591, 1 ea., $200,000.

Slick Airways, Burbank, Calif., CRAF group A modification of contractor-owned CL-44D aircraft, contract AF 33(600)42084 dated Aug. 17, 1960, $81,900.

Kollsman Instrument Corp., Elmhurst, N. Y., indicator, true airspeed, pilot static, type M-5, contractor's P/N 1297C-4-05, FSN 6025-6610-526-4802, Aerno 60-4932, spare parts, ground support equipment and data. RFP RG-1-6610-3461, contract AF 33(600)42573 dated Dec. 12, 1960, 134 ea., $82,003.

Goodyear Aircraft Corp., Akron, Ohio, pallets, cargo aircraft, HCU-6/E iaw/speci-

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of infinity
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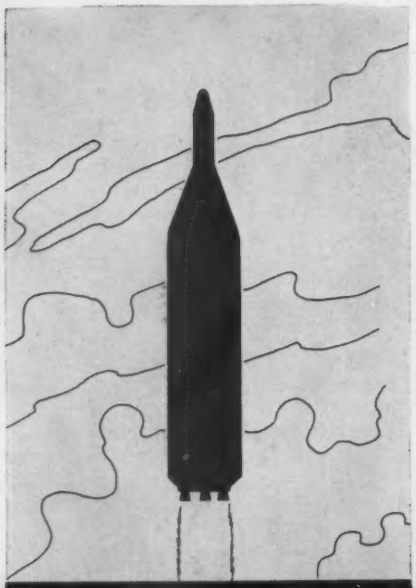
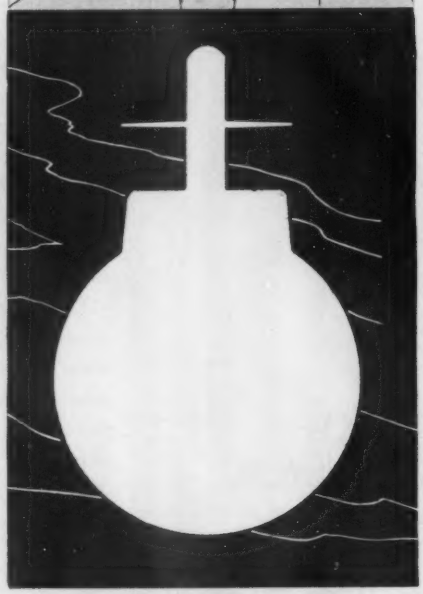
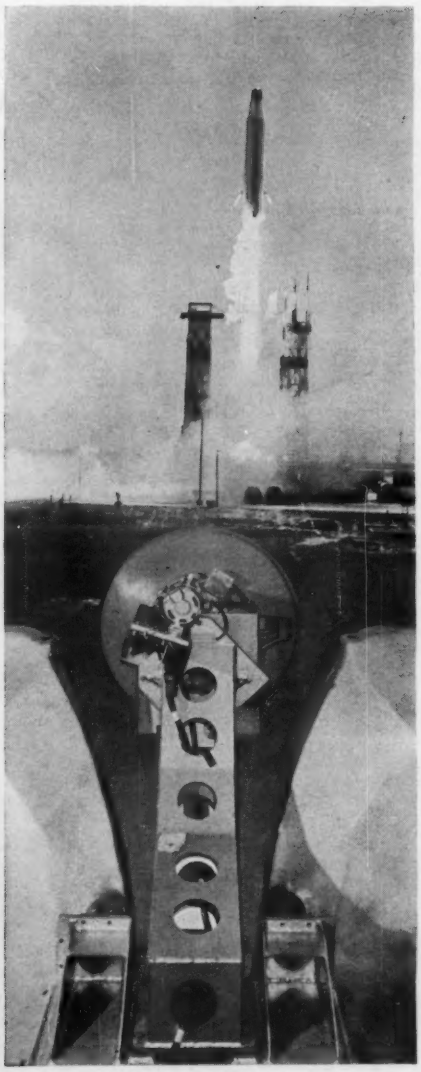




FIRE CONTROL



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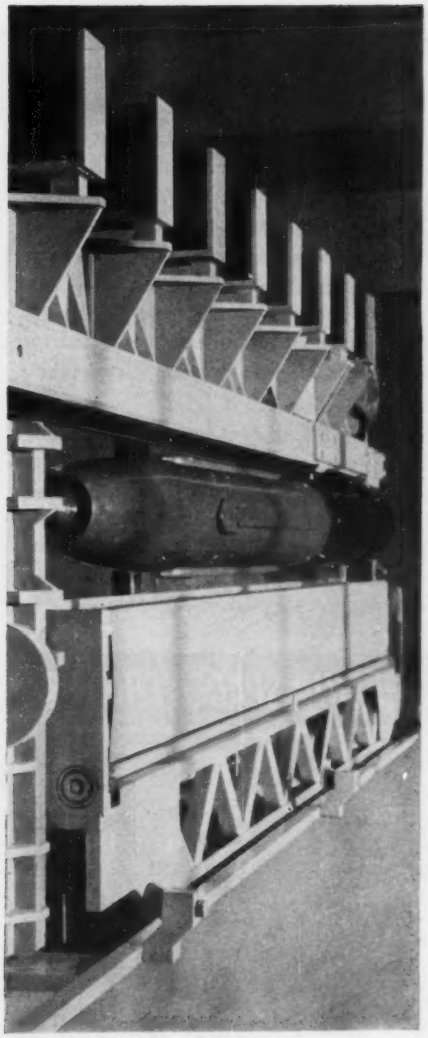

LAUNCHING SYSTEMS

These five products are typical examples of General Electric Ordnance Department's performance in setting the pattern for precision in ordnance equipment today.

HIGH-G INERTIAL GUIDANCE—A prototype High-G Inertial Platform successfully withstood centrifuge accelerations within the 50 to 100-G area during a 30-minute test period. Key to this outstanding performance is the advanced design of this precision system by G.E.'s Ordnance Department. The design features rugged beryllium gimbals, reliable pairs of pre-loaded gimbal bearings, and highly accurate gyro and accelerometer re-designs which represent the furthermost advance in the state of the art.

POLARIS INERTIAL GUIDANCE—After a rugged trip from underneath the sea, the Polaris guidance system accurately places the streaking Polaris on its precise trajectory to a target 1200 miles distant. One of the most advanced inertial guidance systems in a U.S. ballistic missile today, this system was designed by M. I. T., produced by General Electric's Ordnance Department. This guidance system, time after time, performed with precision in the highly successful Polaris Flight Test Program. It was delivered two years ahead of the original Polaris schedule.

POLARIS FIRE CONTROL—This versatile system precisely aims and fires sixteen Polaris missiles in as many minutes from a moving nuclear submarine. This system continually feeds to the missiles' inertial guidance system corrections on the submarine's course, vertical plane and true north reference and instantly compensates for the submarine's pitch, roll and yaw. Designed and produced by General Electric, it was also delivered two years ahead of the original Polaris schedule.

ANTENNAS—The Atlas Guidance Tracker, the Free World's most precise radar antenna for missile guidance, features the unexcelled smoothness and positioning accuracy of the Directrol* Gearless Power Drive. Tolerance of 50 millionths of an inch on the 48-inch diameter base ring assures extreme precision of the two and one-half ton antenna mount.

LAUNCHING SYSTEM—Massive 350-ton Guided Missile Launching System MK 12 will triple the immediate fire power of TALOS missiles aboard the nuclear cruiser *U.S.S. Long Beach*. The precision-built system is rugged enough to support the 7,600-lb. missiles yet flexible enough to compensate for the twisting and turning of a naval vessel at sea. 166-2C

**Patent Pending*

ORDNANCE DEPARTMENT
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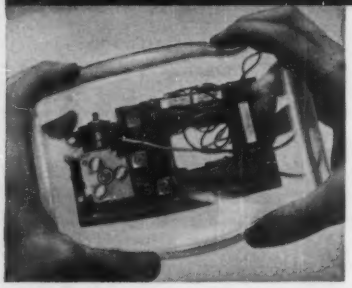
Sixteen and a half minutes after its first manned launching, NASA's blunt-nosed Mercury spacecraft will paradrop into the Atlantic Ocean.

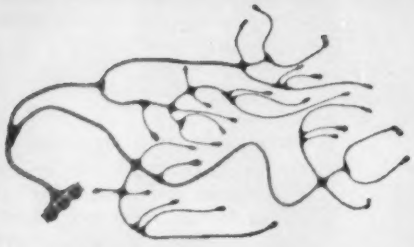
Here it will float like a buoy marker to await recovery. To help protect the first American astronaut, the Mercury spacecraft is completely sealed with General Electric RTV silicone rubber — the new liquid rubber designed to keep the spacecraft air and water tight even after being subjected to the temperature extremes encountered during take-off, flight and re-entry.

McDonnell Aircraft Corporation, prime contractor for the Mercury spacecraft, applies RTV around rivets and bolts wherever structural material, requiring sealing, overlaps or butts together. Able to cure at room temperature, versatile General Electric RTV silicone rubber has found a wide range of uses in missiles and ground support equipment.

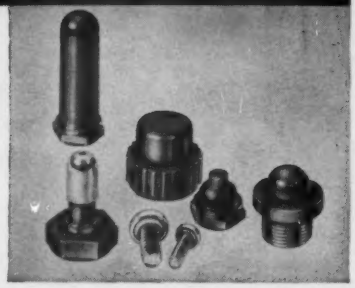
G-E SILICONE RUBBER FINDS MANY USES IN MISSILES AND SPACE VEHICLES



Potting and encapsulating materials protect delicate electronic parts. Clear LTV, shown above, is transparent even in sections several inches thick. RTV liquid silicone rubber encapsulants and clear LTV all exhibit excellent electrical properties, resist shock, vibration, ozone, plus corona and other environmental hazards.



Missile wiring harness, above, is from the Titan propulsion system. G-E silicone rubber wire insulation maintains good electrical properties over wide temperature extremes. Jacketing of high-strength silicone rubber, plus breakouts and junctions molded from RTV were chosen for their insulating properties, resistance to temperature extremes and stability in storage.



Silicone rubber gaskets and seals give long life, heat resistance, and low temperature flexibility in many missiles and space vehicles. Applications range from nose cone gaskets to tiny Seelskrews and Hexseals, by Automatic and Precision Mfg. Company, which combine fasteners with silicone rubber seals for easy assembly.

For full information on General Electric RTV silicone rubber, clear LTV silicone compound, and fabricated silicone rubber parts, write: General Electric Company, Silicone Products Dept., Section J444, Waterford, New York.

GENERAL ELECTRIC

fication MIL-P-27443 and amended thereto, 1000 ea.; nets, cargo tiedown, pallet, HCU-7/E law/specification MIL-N-27444 and amended thereto, 1000 ea.; maintenance and repair manuals, IFB 33-600-61-80 and amendments 1 and 2, contract AF 33(600) 42626 dated Feb. 9, 1961, $634,060.

AiResearch Manufacturing Co., Phoenix, Ariz., power units, gas turbine engine type A/A 32A-3, law/contractor's model GTC 85-71 drawing No. SC 376730, FSN 2835-684-8097, Aerno 42-2352 (installation and spares for G-130E aircraft) spare parts, ground support equipment and related data, contract AF 33(600)42650 dated Jan. 6, 1961, 84 ea., $915,180.

Lockheed Aircraft Corp., Marietta, Ga., C-130B aircraft, law/contractor's model specification ER-4800M dated Feb. 15, 1960, letter contract designated supplemental agreement No. 5 dated Feb. 6, 1961, to contract AF 33(600)40997, $1,000,000.

General Electric Co., X-ray Dept., Milwaukee, Wis., spare parts for the C-11 and LD-45A magazine and the M-2 control exposure frequency, contract AF 33(600)42533 dated Jan. 6, 1961, $104,825.

Aerial Machine & Tool Corp., Long Island City, N. Y., belt, aircraft safety, lap, troop type MC-1A, FSN 4502-1680-725-5927, Aerno 45-2429 (for USAF installations) 13326 ea.; harness, shoulder, aircraft safety, type G-1, Aerno 45-2431, FSN 4502-1680-485-3047 (installations for HU-1B aircraft) 276 ea., IFB 33-600-61-108, contract AF 33(600)42723 dated Feb. 10, 1961, $58,863.

International Business Machines Corp., Federal Systems Div., Oswego, N. Y., various quantities of components of bombing navigational system, type AN/ASB-4/9 (installations for B-52 aircraft) letter contract AF 33(600)42712 dated Jan. 16, 1961, $295,000.

Boeing Airplane Co., Wichita, Kan., additional facilities for the B-52 program, supplemental agreement No. 1 dated Jan. 3, 1961, to contract AF 33(600)41399, $416,405.

Radio Corp. of America, Electron Tube Division, Lancaster, Pa., facilities for the testing of high powered tubes, contract AF 33(600)42022 dated Aug. 31, 1960, $492,353. $492,353.

Temco Aircraft Corp., Greenville, Tex., C-130A aircraft modification, letter contract AF 33(600)42716, dated Jan. 30, 1961, $1,500,000.

General Electric Co., West Lynn, Mass., indicators, electrical tachometer aircraft turbo speed, Aerno 61-0225, FSN 6119-6620-581-2238, contractor's P/N 8DJ81-CAA-1, spare parts and data (installations and spares for MTU, B-52H, C-133B-2, C-130E, KC-135A, HU-1B and HC-1B aircraft. RFPs RG-1-6620-3607, RG-1-6620-3608, RG-1-6620-3608-1 and RG-1-6620-3609, contract AF 33(600)42633, dated Jan. 24, 1961, 388 ea., $46,360.

North American Aviation, Inc., Autonetics Div., Downey, Calif., modernization of facilities and transfer of additional facilities, supplemental agreement No. 1 dated Oct. 3, 1960, to contract AF 33(600)34559, $332,247.

Avco, Lycoming Div., Williamsport, Pa., 0-480-3 reciprocating engines law/contractor's model specification 2218 dated Jan. 9, 1961 (installations and spares for L23-F aircraft) supplemental agreement No. 1 dated Oct. 26, 1960, to contract AF 33(600)41924, 15 ea., $95,955.

Boeing Airplane Co., Seattle, Wash., model C-135A airplanes law/contractor's model specifications D-6-7193 entitled "Detailed Specification Transport C-135A" dated Feb. 6, 1961, amendment No. 1 dated Feb. 6, 1961, to letter contract AF 33(600) 41979, $10,000,000.

General Precision, Inc., Link Div., Binghamton, N. Y., instrument flight trainers, type AF 37A-T7, spare parts, data and installation services, letter contract AF 33 (600)42399, dated Jan. 19, 1961, $884,800.

Boeing Airplane Co., Vertol Div., Morton, Pa., HC-1B helicopters, airframe repair parts, ground support equipment, special tools and data, contract AF 33(600)-42055 dated Dec. 5, 1960, $26,045,008.

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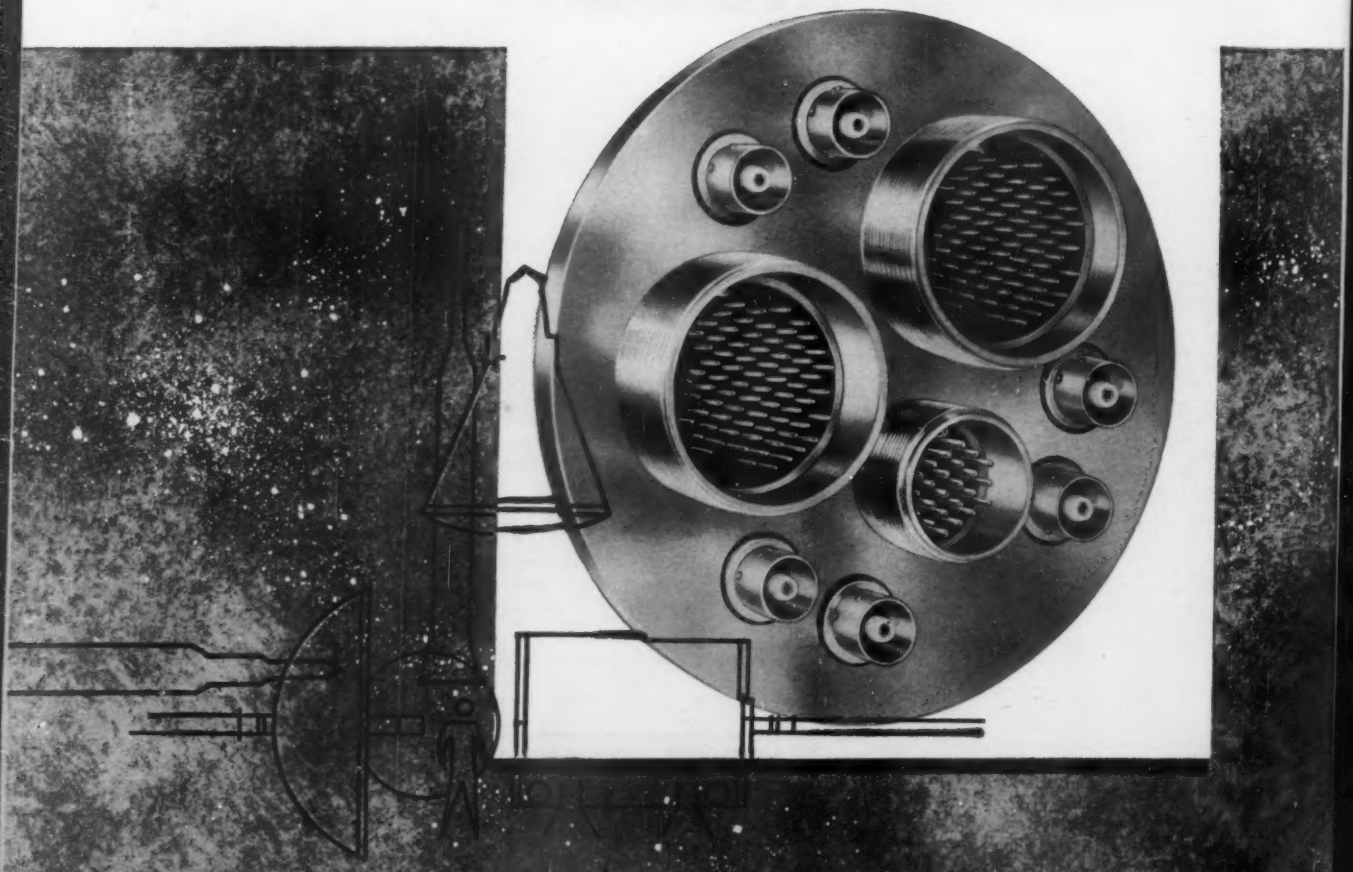

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SAFETY

Danish Accident Investigation Report, Part 1:

Caravelle Descent Too Low on Approach

This is the first installment of a two-part Danish Accident Investigation Report on the crash of a Scandinavian Airlines System Sud Aviation Caravelle jet transport at Esenboga Airport, Ankara, Turkey, during a low approach (AW Mar. 20, p. 45).

The accident occurred at 1847Z* on 19th of January, 1960, at a point approximately 6 naut. mi. from the threshold of Runway 03 and approximately 300 meters to the right of the extended centerline of that runway. The aircraft was destroyed and the 7 crew members and 35 passengers were killed in the accident.

The accident occurred during the approach to Esenboga Airport when the aircraft was on a scheduled international public transport flight.

The aircraft was a Sud Aviation SE-210 Caravelle I with nationality and registration marks OY-KRB.

The aircraft was owned by "Det Danske Luftfartselskab A/S" (Danish Airlines), Copenhagen, Denmark (one of the three companies of the SAS consortium), and was operated by the Scandinavian Airlines System.

Summary

SK 871 was a normal scheduled flight between Copenhagen and Cairo. After takeoff from Istanbul at 1803Z the aircraft proceeded to the next intermediate stop which was Ankara.

Everything seems to have been normal when SK 871 was taken over by Ankara control at reporting point Goynuk at 1826Z and the flight was close to the flight plan delivered to ATC Istanbul. SK 871 was cleared to the Ankara range station and was slightly delayed in descent due to outbound traffic, but no delay was expected for the approach.

The aircraft arrived over the range station at 1841Z at flight level 13,500 ft. descending to 12,000 ft. which was in accordance with the clearance given. At 1843Z Scandinavian 871 changed over to tower frequency and received further let-down and approach instructions. The crew acknowledged receipt of the clearance and the flight reported Ankara range station inbound at 1845Z at an altitude of 6,500 ft. descending. The flight until now seems to have been of a routine character, as nothing special had been reported from the aircraft.

At 1847Z the aircraft crashed between Ankara Range and the airport.

The aircraft had a valid Certificate of Airworthiness. The aircraft was properly loaded at departure from Istanbul and the gross weight and the center of gravity were within the prescribed limits.

The maintenance of the aircraft was carried out in accordance with the maintenance schedule laid down by the operator and approved by the State of Registry.

From the technical remarks in the aircraft log it is known that there has been one occasion where the altimeters and the rate of climb indicators have moved in steps of the order of 100 ft. during a final approach in clouds and rain, possibly due to water in the static lines. None of the other technical remarks seems to have any bearing on the accident.

The cockpit crew on the flight were Capt. Lars K. Retvedt, 1st Officer A. M. Henriksson and 1st Officer K. Finnevolden.

The crew were on an ordinary crewsling and left Copenhagen on Jan. 17, arriving at Istanbul in the afternoon on the same day. They were then off duty until the departure of OY-KRB on Jan. 19, 48 hr. after arrival at Istanbul.

An inquiry into the conduct of the crew during their stay in Istanbul has given no basis for the assumption that they should have been fatigued or under the influence of alcohol at the time of departure.

An autopsy of the captain revealed no signs of illness which could have had any bearing on his ability to fly the aircraft.

The crew were all duly certified, they had received the prescribed training on the aircraft type in question and had likewise been through the route training for the route concerned.

Capt. Retvedt had 310 hr. flying experience with this type of aircraft, 1st Officer A. M. Henriksson 280 hr. and 1st Officer K. Finnevolden 250 hr.

The regulations for flight time limitation and rest periods as laid down by the operator and approved by the State of Registry, were duly observed.

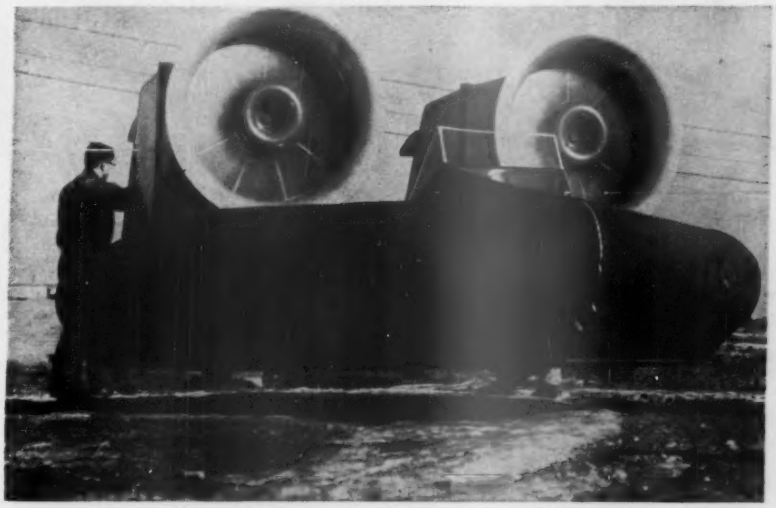
It can be stated that Capt. Retvedt was at the controls and that 1st Officer Henriksson acted as a copilot and handled the VHF communication.

1st Officer Finnevolden was the third crew member and was a qualified copilot on this type of aircraft.

The airworthiness specifications for the Caravelle require that such a crew member must be carried until the fuel heating system and the servodyne heating system have been modified for pilot operation.

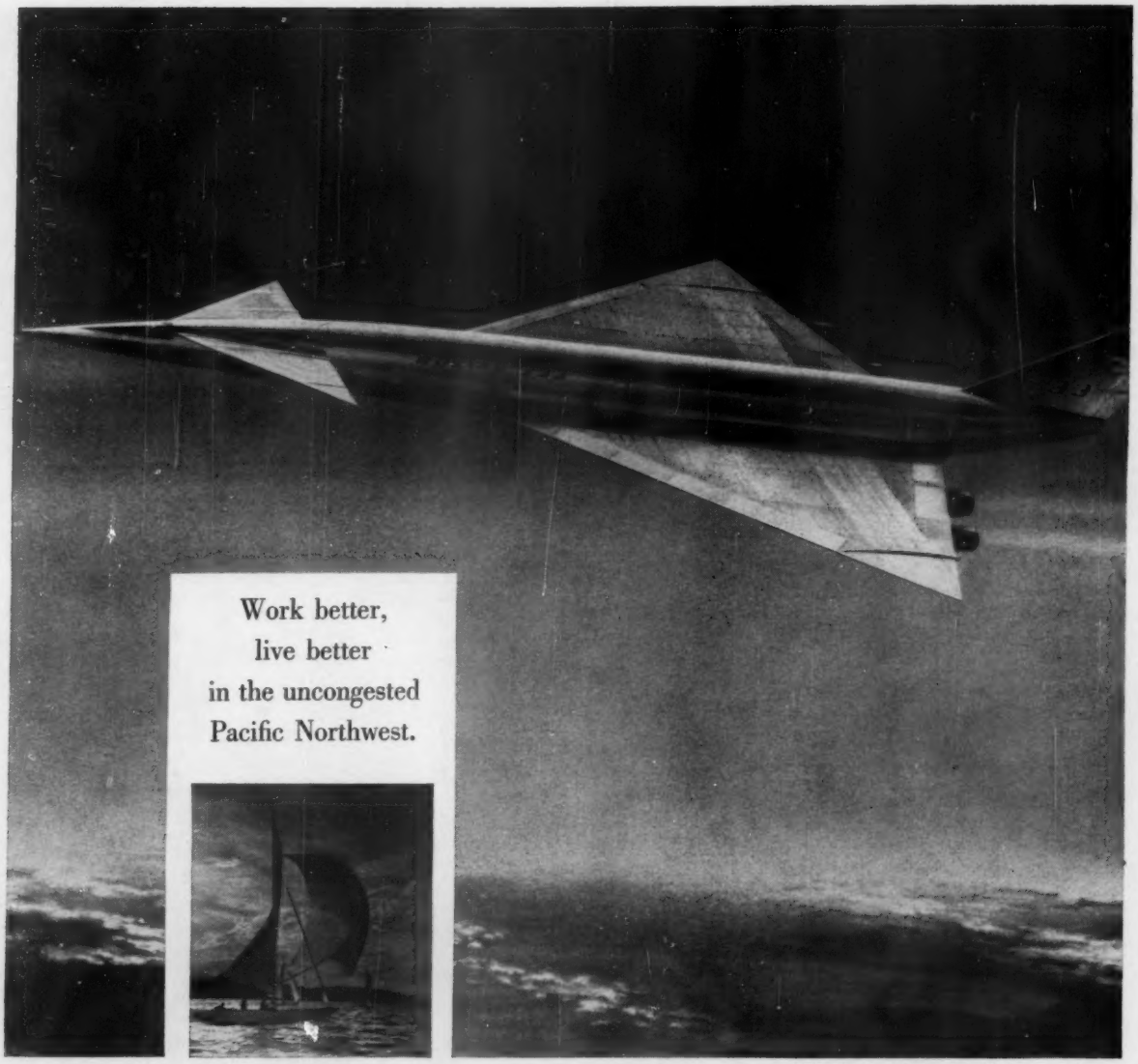
An inquiry among the operator's flight staff revealed that Capt. Retvedt was known always strictly to have adhered to laid-down procedures, and that he was very careful

* Z—Greenwich Mean Time



GEM III Delivered to Marines

GEM III ground-effect machine, powered by a pair of Solar YT62 Titan gas turbines rated at 80 shp. each, has been delivered to the U. S. Marine Corps by National Research Associates, Inc. Vehicle weighs 1,835 lb., has approximately twice that weight as lifting capacity, says the company. GEM III is approximately 22-ft. long, 12-ft. wide; hover height is about 18 in. Design speed is 30 mph. Structure is aluminum alloy, with a foam-plastic base for water buoyancy and wheels for ground handling. Lift is provided by the peripheral jet, with multiple vanes in the jet nozzle used to deflect the jet to provide both propulsion and directional control. Lateral and pitch controls and off-center trim are handled by pressure-relief valves.



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with the planning of a flight. 1st Officer Henriksson and 1st Officer Finnevolden were known as capable copilots who executed their crew duties very satisfactorily.

The forecast and the information on actual weather which the crew received before the departure from Istanbul and during the flight were consistent with, or slightly more pessimistic than, the actual weather encountered.

Local Weather

The local weather in the mountains between Ankara Range and Esenboga Airport was the only exemption. Due to the terrain, the weather here was very bad with low ceiling and bad visibility in rain and snow below the clouds.

It may be assumed that Capt. Retvedt had the impression that the forecast and the actual reported weather for the airport were valid also for the approach path over the mountains, as he may possibly have seen the lights from Ankara City during the letdown on the range.

Therefore it might be possible that the captain was unprepared for a normal instrument approach.

The weather conditions over the mountains may therefore have taken him by surprise. It is known that moderate icing conditions existed in the cloud layers.

The position of the impact point relative to the normal approach path indicates that proper navigational guidance was available when ADF and ILS localizer was being used for the approach.

The technical investigation revealed that the Red ADF (radio compass) was tuned in on NDB AN and that the Green ADF had a setting of 270. This frequency corresponds to NDB ETM. This NDB may possibly have been used during the procedure turn on Ankara Range. Since the function selector was in ANT position, it is likely, however, that the Green ADF was in the course of being reset at the time of impact, possibly for tuning in on NDB NK (260 kc.). Both UHF navigational receivers were tuned for Ankara ILS. The localizer transmitter of this ILS was in use "on test," but the glide path transmitter was not operating.

The possibility may exist that an ILS approach was performed with the aid of the horizon flight director without the crew knowing or noticing the absence of the glide path signal. A similar case has been reported to the investigation group.

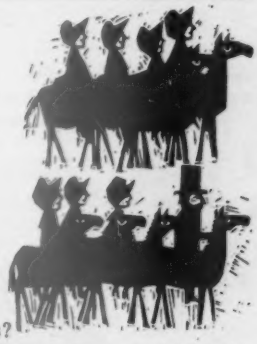
Tape Recordings

The tape recordings of the correspondence between the aircraft and the ATC at Istanbul show that nothing hampered communication with the aircraft. This is also in conformity with the recorded communication with Ankara Control and Esenboga Tower.

It had thus been possible for the crew to report any distress that they may have encountered. It has been said that an aircraft belonging to Lufthansa should have received a distress message from OY-KRB, but according to Lufthansa this is not the case.

Measurements of the marks of the first impact were taken at the site of the accident and all more significant parts of the wreckage were registered and their relative

PROBLEMATICAL RECREATIONS 62



Between Sing-Sing and Tarry-Town,
I met my worthy friend, John Brown,
And seven daughters, riding nags,
And every one had seven bags.
In every bag were thirty cats,
And every cat had forty rats,
Besides a brood of fifty kittens.
All *but* the nags were wearing mittens!
Mittens, kittens — cats, rats — bags,
nags — Browns,
How many were met between the towns?

—Matoon's Common Arithmetic

Big things from tiny crystals will grow in the new semi-conductor lab at our Airtron Division's Advanced Devices Laboratory. Recently constructed, the new dust-free, controlled-temperature lab is being used to perfect a varactor diode, main component for a new line of parametric amplifiers. Look for Airtron's product line to broaden as the new semi-conductor lab advances its research into new materials.

ANSWER TO LAST WEEK'S PROBLEM: If the prisoner places one white ball in one box and the remaining balls (9 white and 10 black) in the other box, his chance of survival would be $(1 + 9/19)/2 = 0.737$, or 73.7%.

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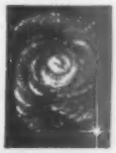

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WE'RE CLOSER THAN YOU THINK...

Reading clockwise: Venus, Moon, Mars. Approximate distance from Venus to Earth, 25,000,000 miles; from Moon, 240,000 miles; from Mars, 50,000,000 miles.

Photos courtesy of Mount Wilson and Palomar Observatories.

positions, established. Photos were taken of all significant evidence in the area.

Based upon this information, calculations were made of impact-forces and the attitude of the aircraft, before and after the first impact. This established that the aircraft hit the ground in a normal flight attitude at an angle of attack of approximately 5 deg. and an airspeed of approximately 160 kt. Impact marks were made by the landing gear and the right speed-brake.

A scale model of the first impact area was made, and tests, carried out with a model of the aircraft, confirm these calculations.

Photos of the impact sequence were taken as well as photos of the presumed attitude of the aircraft after the impact. A search for impact marks or pieces of the aircraft, that might indicate ground contact earlier than the crash site, or a midair explosion, was carried out with negative result.

The marks of the first impact at the crash site indicate that the flight path may possibly have cleared the nearest hill in the direction of Ankara Range with a small margin, only. A search on this hill showed no evidence of ground contact.

The technical investigation at the accident site mainly consisted in the collection of all parts that might give indications of the airworthiness of the aircraft immediately before the crash and of all parts that might present a clue as to the manner in which the aircraft was being flown during the last part of the flight. 326 parts were recovered, and after having been brought to Scandinavia, preliminarily examined.

A summary of the results of the investigation is given below.

Air Conditioning System

The air conditioning system is supplied with air under pressure bleed directly from the two jet engines. One engine supplies the cabin area and the other mainly supplies the cockpit but has also a bleed to the cabin. Each supply line has an electrically operated air conditioning master shut-off valve mounted close to the engine.

These two valves were found in CLOSED position. The valves will close under the following conditions:

- **When the air conditioning** master valve switch in the cockpit is switched to CLOSED position. Closing time 80 sec.
- **When the power levers** are moved forward to a position corresponding to 7700-7900 rpm. Closing time 12 sec.
- **When the engines** are stopped. Closing time 12 sec.
- **In case of air duct overheating.** Closing time 12 sec.
- **If the air duct** overheat warning test button is pressed in. Closing time 12 sec.

Of the conditions listed above the first is the most likely, this being the normal procedure according to item 14 on the cockpit check list.

The second condition, that the closing of the valves is initiated by the opening up of the power levers, due to an intended pull-up, cannot altogether be precluded, but there is no other indication of such intention (speed-brakes and landing gear out, flaps under extension).

The third condition is very remote, for one thing because the engines were under power at the time of the first impact and, for another, because electrical power could not have been available for 12 sec. after the first impact. A potential operation of the valve, due to impact damage to the circuit, is thus excluded.

Neither is the fourth condition probable, a simultaneous overheat in both supply lines not being likely.

Condition No. 5 seems reasonable only in case of smoke in the cockpit prior to the impact.

Examination of the autopilot servos revealed that the aileron servo displays defects, which might probably indicate that the servo in question was not in use at the time of the impact.

In SAS operations the autopilot is normally not used during approach, except for automatic approaches.

Since Ankara ILS was on test, only, and without glide path it must be assumed that the autopilot was not engaged at the time of the impact.

It has been ascertained to which frequencies the ADFs and the VHFs were tuned, but, due to the very extensive damage to all units, it has not been possible to prove the serviceability of this equipment at the time of the impact. Based on the radio communication immediately before the crash, and the position of the accident site relative to the normal approach path, it may, however, be assumed that no malfunctioning of the radio equipment endangering the flight had been experienced.

Examination of the flight control system vibrators proves that the d.c. supply system must have been under power at the time of the first impact or at least up to a few seconds before this impact. Consequently there had been electrical power available and no unintentional operation of the general (master) switch occurred.

The powerplant fire protection system, comprising four extinguisher agent bottles, was not used, since all bottles were found fully charged.

If engine fire had occurred it must have started so soon before the crash that the time would not have been sufficient for the crew to operate the system. Consequently, engine fire can not be considered the cause of the aircraft's descent below minimum safe altitude.

Examination of the portable fire extinguishers, placed in the cockpit and in the passenger cabin, reveals that they were not in use.

SE-210 is equipped with a fully powered

Bell HU-1As Assigned to Alaska

First three of 10 Bell HU-1A turbine-powered helicopters assigned to duty with U. S. Army units in Alaska are shown near the company's Hurst, Tex., plant during acceptance trials prior to delivery. Arctic high-visibility paint scheme of red, white and yellow has been applied in place of standard olive drab. All 10 HU-1As will be assigned to Fort Richardson, near Anchorage.

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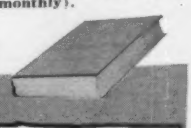

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flight control system without manual reversion. The power units, hereinafter referred to as servodynes, are all located very close to the control surfaces to minimize backlashes. Each servodyne is duplicated in tandem and operated by separate hydraulic supplies to either side of the servodynes (green and blue system). In addition to the duplicated normal hydraulic supplies there is an extra standby hydraulic supply (yellow system) from an electrical pump which can be switched to either side of the servodynes.

The control valves on the servodynes are operated through cables from the control column and the rudder pedals, respectively. Trimming is performed through independent trim cables from the cockpit trim wheels to the trim mechanism which actuates the normal control valves in the servodynes.

An artificial feel system is provided for elevator and rudder to produce stick forces representative of speed changes.

Elevator Control

The elevator flight control system is also provided with a pitch corrector unit which is electrically actuated from the stall warning system. The pitch corrector trims 2 deg. nose-down at angle of attack of 19 deg. and at an airspeed less than 170 kt.

Due to the extensive damage resulting from impact forces and fire, most of the wires, connecting rods, etc., could not be examined. The few parts that were recovered showed no signs of pre-crash failure. It might be mentioned that flight tests have shown that the aircraft may be flown and landed on the trim controls alone (i.e. after the flight controls in the cockpit have been separated from the servodyne control valves).

A short time after the crash of OY-KRB, a fatigue failure of an elevator trim wire on another Caravelle aircraft was experienced during ground test. Investigations showed that, in case of a sudden failure of an elevator trim cable, changes in trim of 3-4 deg., depending on the location of the failure, were possible, the figures being based on zero aerodynamic load.

The wire that failed had been working for 1,672 hr. since new. Tests made by the Aeronautical Research Institute of Sweden have shown that, although an operating time of 800 hr. has no recognizable effect on the strength of the wire, 1,500 hr. of operation means an appreciable reduction.

Based on the above-mentioned facts, the maximum operating time for said wires has been fixed at 500 hr.

The total operating time of OY-KRB at the time of the crash was 474 hr. and, consequently, fatigue failure of the elevator trim wire is considered highly improbable.

Examination and test showed the elevator servodyne to be completely serviceable as found. During the subsequent disassembly several steel chips and other foreign matter were found upstream of the servodyne control valve filters.

Those chips, etc., most probably originate from the servodyne maneuvering cylinder. One steel chip was found in the filter downstream of the servodyne control valve. One steel chip was found in the maneuvering cylinder of the green system.

Foreign matter (steel chips) in the servodyne in the vicinity of the servodyne control valve may make this valve stick. In this case the Servo Failure Warning in the cockpit is lighted for the system (green or blue) in question. After selecting the appropriate system OFF, the servodyne will operate normally.

Foreign matter in the servodyne maneuvering cylinder may have caused the servodyne piston check valve to stick in open position. Analysis of this situation, made in cooperation with Sud Aviation, shows that, even when the check valve is stuck in the full open position, the resulting servodyne forces will be such as to make continued flight without loss of altitude possible. Examination and test showed the rudder servodyne to be completely serviceable as found.

Also in this servodyne, foreign matter (steel and aluminum chips) was found. Furthermore it was observed that the inlet filter of the green system, due to a manufacturing error, was bypassing particles smaller than 0.5 mm.

An abnormal wear of the servodyne guides allowed the servodyne to touch an electrical system bracket but not to such an extent as to interfere with the free movement of the servodyne.

Examination and test showed both aileron servodynes to be completely serviceable as found. Those servodynes, too, contained a certain amount of foreign matter.

The aileron system, furthermore, is so designed as to make lateral control possible, even in case of one servodyne being unserviceable.

There is no reason to believe that any failure of the artificial feel system could have contributed to the accident, it being possible to fly the aircraft without this system. Based on the above-mentioned facts it must be considered improbable that any defect of malfunctioning has occurred in the system of the primary flight controls at the moment of the crash. The possibility remains, however, of a temporary malfunctioning at an earlier time during the approach, caused by the conditions stated above.

Secondary Controls

The vital parts of the wing flap mechanisms, the wing flap drive hydraulic motor, the mechanical stop unit and the most inboard and outboard drive screws on both starboard and port wings were recovered from the wreckage. Examination of the hydraulic motor revealed with certainty that it was fully serviceable at the time of impact.

Examination of the mechanical stop unit did not disclose any failure of the unit. The construction of the unit is such as to make it possible from the position of the mechanism definitely to establish whether the flaps were on their way out or in. In this particular case the flaps were on their way out.

The drive screws are all locked in a position corresponding to a flaps extension of 3.5 deg.

Flight tests on another Caravelle aircraft have revealed that the time for extending

the wing flaps to 3.5 deg. under the conditions likely to have existed under the approach into Esenboga Airport is between 7.8 and 11.5 sec., on the assumption of availability of normal hydraulic power.

The speed brakes are actuated by two speed brake cylinders on each wing. All four cylinders together with the two speed brake lock-out valves were recovered from the wreckage.

The ground marks of the first impact disclose that the right hand wing speed brake was extended during impact.

In addition, the two speed brake cylinders from that wing were found fully extended and the piston rods were bent 30 deg. in extended position due to impact forces. It is thus evident that the right hand wing speed brake was extended during impact. The speed brake cylinders of the left hand wing speed brake were found partly extended respectively 85 mm. and 16 mm. (Full travel is 217 mm.). This indicates that the left hand wing speed brake was not retracted, but there is no sure evidence that the speed brake was fully extended.

No failure was found during the strip-down inspection of this particular lock-out valve, and analysis of the possibilities of a split position, due to a sticking valve in the lock-out valve unit, shows that it is very unlikely that such failure could actually have been experienced during OY-KRB's approach to Esenboga Airport.

It is thus very likely that both speed brakes were extended during the first impact. Wind tunnel tests have disclosed that there should be no difficulties in controlling the aircraft by using the primary flying controls under split speed brake conditions.

Fuel and Fuel System

OY-KRB was refuelled with 7,750 litres of kerosene in Istanbul during the ground stop. Fuel samples from the fuel-truck, which had been used for refueling, were taken as soon as Istanbul was informed of the accident. Analysis at the Material Laboratory at the Royal Swedish Air Force Test Center revealed that the fuel was in compliance with the specified requirements.

After refueling, OY-KRB had a fuel load of 11,000 kg. The calculated fuel consumption from Istanbul to Ankara according to the flight plan was 2,615 kg., and it is assumed that the consumption up to the time of the accident was roughly 2,400 kg.

The fuel valves were secured from the wreckage and were all found in normal position, i.e. the four tank valves open and the cross-feed valve closed.

Before departure from Istanbul OY-KRB had experienced a malfunctioning of the left hand main fuel tank valve. The magnetic valve position indicator in the cockpit did not indicate that the valve opened, when the switch was switched to open position during the Before Starting Engine check. The crew consulted the station mechanic and after having operated the switch a few times, the magnetic indicator showed that the valve was open. The valve was found in this position at the wreckage.

The investigation of the engines shows that they were under power at the time of the first impact.

On the basis of what has been stated above, it must be concluded that OY-KRB was properly fueled at Istanbul and that fuel starvation has not had any bearing on the accident.

The hydraulic power supply system on the Caravelle comprises four independent systems as follows:

- **Green system,** normally feeding the flight control servos and all other hydraulic systems except the artificial feel system.
- **Blue system,** a system parallel to the green system and normally feeding the flight control servos and the artificial feel system.
- **Yellow system,** a stand-by system for the green and blue flight control systems.
- **Red system,** a stand-by system for the green system in respect of wing flap and landing gear and wheel brakes.

Green System Checked

Examination of components of the green system has revealed no defects. As mentioned above, the red system is stand-by for the green system in respect of wing flap maneuvering. At the moment of the first impact the wing flaps were in position 3½ deg., moving down, and as the selector handle for the red system was found locked in closed position, the green system has been supplying the flaps and, consequently, it must have been serviceable up to the moment of flap extension.

Examination of components of the blue system has revealed no defect. The shut-off valves of both blue hydraulic pumps were found in open position. Consequently there does not appear to have been any loss of hydraulic fluid as, otherwise, those valves would have been closed by the crew, time permitting this operation. (The valves are electrically operated and the operating time from open to closed position is approximately 1 sec.). Based on the above-mentioned facts, the blue system appears to have been serviceable until the time of the impact.

It has not been possible to ascertain whether the electrically operated hydraulic pump of the yellow system was serviceable up to the time of the crash. However, both the green and the blue system appear to have been serviceable, and consequently the yellow system can be disregarded.

The selector valves for the red system were found locked in closed position. Consequently, this system has not been in use.

At the time of the crash it was normal practice to keep the electrically operated hydraulic pump running during flight, regardless of whether the system was in use or not.

The pump is positioned adjacent to the cockpit and a short-circuit in the motor will generate smoke, thus hampering the work of the crew. The pump motor was damaged to such an extent that it was impossible to ascertain whether a short-circuit had occurred.

In summarizing, it can be stated that it is most likely that the entire hydraulic power supply system was functioning correctly at the time of the impact.

The de-icing system is supplied with hot air under pressure bleed directly from the two jet engines. Situated close to each engine is an electrically operated de-icing master shut-off valve. From these valves hot air is routed to the various systems for airfoil de-icing, servodyne heating, fuel heating, nacelle and engine air intake de-icing, nacelle ventilation, and hydraulic reservoir pressurization.

The first four de-icing and heating systems are operated through electrical valves. In case of electrical power cutoff, these valves and the de-icing master shut-off valves will remain in the position they had at the moment of power cut-off.

In addition to the above described main de-icing system, each system is provided with an internal engine anti-icing system. This system is supplied from two gate valves on each engine. These valves are also electrically operated.

All the said valves were recovered from the wreckage and their respective positions give the following indications:

- **The airfoil de-icing system,** the servodyne heating system, the nacelle and air intake de-icing system and the engine internal anti-icing system all appear to have been in switch-ON position at the time of the first impact.
- **The de-icing master valves** may probably have closed between the first and the second impact due to short circuit or other electrical disturbances imposed by the first impact.

Due to the fragile nature of most of the instruments, the impact damage has considerably limited the possibilities of making reliable observations from inspection and strip-down of the various items.

However, it has been possible to deduce the following findings:

Pitot, Static System

That part of the pitot and static system that was recovered showed no sign of malfunctioning. The airspeed indicators and rate of climb indicators were so badly damaged that no conclusions were possible. All three altimeters were so badly damaged that no conclusions regarding the height indication at the time of impact were possible, but the barometric settings could be read and showed within a few millibars (1-3 mb.) the QNH value given by Ankara Tower.

Although no indications of malfunctions have been found, the possibility thereof can not be fully excluded. The most dangerous type of malfunction would in this particular case be a sticking of the captain's primary altimeter.

Of the three altimeters in OY-KRB two were of the old type with three pointers and one (captain's primary) was of the new drum type with the indication of each full thousand of feet on a revolving drum and the intervening values by means of a normal pointer and dial presentation.

One case of a sticking drum altimeter was recently reported in the case of another Caravelle aircraft, and an investigation revealed some very small particles inside the housing of the altimeter of this aircraft (metal chips and a piece of bristle). These particles may have caused the sticking. A sticking of one of the altimeters in OY-KRB due to this or to other causes cannot be fully excluded, but it is extremely improbable that this will occur in more than one altimeter at a time.

Due to the fact that the aircraft passed through clouds with rain, snow or sleet,

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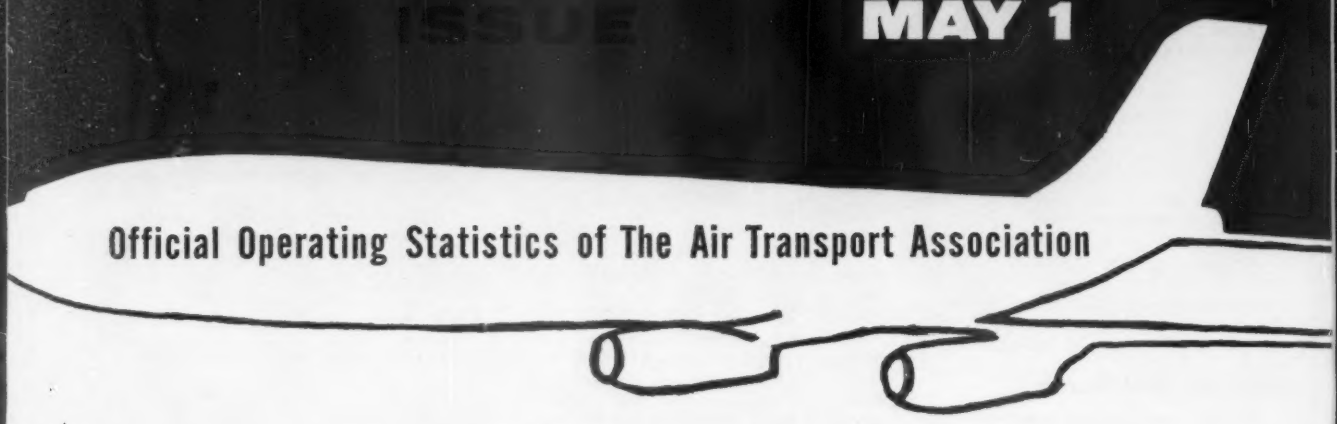

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it is also possible that a somewhat fluctuating altitude indication may have been experienced. A freezing of the pitot and static system at the prevailing temperatures is improbable.

The integrated instrument, or flight director system in the Caravelle comprises four panel instruments, the horizon flight director, two compass indicators and the pictorial deviation indicator and, in addition, a flight reference selector. These instruments are electrical indicators, which get their information from different sources. The pictorial deviation indicator is basically a VOR-ILS indicator with a VOR track selector and with a moving background, that gives an indication of the aircraft's position relative to the beam.

The compass indicator combines the function of the compass master indicator and the radio compass indicator (ADF-RMI : VOR-RMI).

The horizon flight director is a gyro horizon remotely controlled from the three axis data generator and combined with a command bar display. The purpose of this display is to present command signals to the pilots from information collected from the other instruments and modified in the flight director computer as "what to do" signals. The mode of operation is selected by means of the flight reference selector.

Six of the indicators and the two three axis data generators were recovered from the wreckage. Although the impact forces have caused disagreement between the heading indications of the various components, it is believed from the analysis of the system that the ILS has been selected for an inbound heading of 033 deg. corresponding to an approach to Runway 03 on Esenboga Airport. (Both VHF navigational receivers were tuned for Ankara ILS.)

It has been impossible to verify any malfunctioning of the system, but due to the complicated nature of the system, a malfunctioning cannot be excluded. From this system it has not been possible to reach any conclusion regarding the attitude of the aircraft at the time of the first impact.

Examination of the main gear retracting cylinders revealed that both main landing gears had been fully down and in locked position before the impact. The retracting cylinder for the nose gear was not found. From the impact marks it is evident that the nose gear was down.

One landing light was found in retracted position. It is therefore concluded that the landing lights were not switched on for final approach at the moment of the first impact.

From the examination of the wreckage it is not possible to establish whether or not the crew oxygen system or the portable oxygen bottles for passengers were in use at the time of the impact. However, it is not believed that the oxygen system could have had any influence on the accident as there is no indication of any serious malfunctioning of the cabin pressurization system.

As no piece of the aircraft was found prior to the first impact in spite of intensive search, it is evident that no midair disintegration had occurred.

From the marks made in the first impact it is believed that the aircraft struck the ground in almost level flight and at a speed of approximately 160-180 kt. This configuration is not likely to be consistent with serious structural deficiencies.

The investigation of the two engines disclosed that evidently no powerplant failure had been experienced prior to the impact, all bearings have been found to be in satisfactory condition, and no foreign material found in the oil filters. Based upon the impact damage to the engines, it is certain that both engines were running hitting the ground.

From the inlet guide vanes and the Stage 4 bleed valve on the starboard engine it is assumed that the speed of this engine at the time of engine impact was between 6,000 and 7,000 rpm. This is also probable from the impact damage of the engine. The impact damage sustained by the port engine appears to correspond with the rpm. concluded for the starboard engine, when taking into consideration that this engine may probably have had a longer run-down time before finally hitting the ground.

Assuming that the fuel flow to the engines was interrupted around 3 sec. prior to the engine impact, the speed of the engines would be in the order of 8,000 rpm., when the aircraft struck the ground for the second time. The position of the engine internal anti-icing gate valves, which are governed either by microswitches in the throttle pedestal or by the engine de-icing control switch, indicates that the engines

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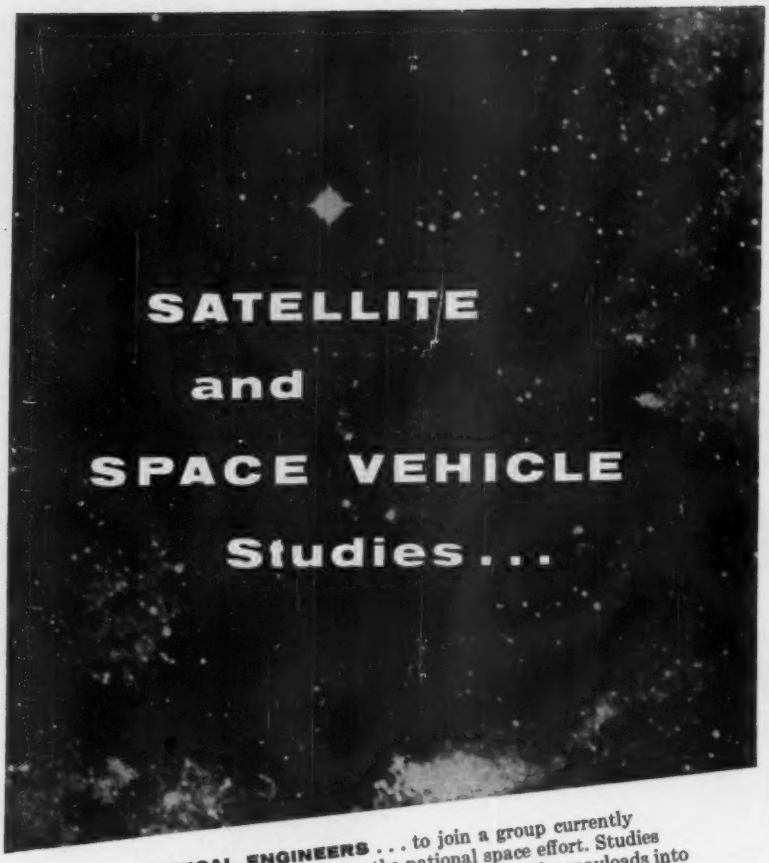

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were running at approximately 7,700 to 7,900 rpm.

On the basis of the above arguments it is assumed that both engines were running at a speed in the order of 6,000 to 8,000 rpm. at the time of the first impact of the aircraft.

The investigation has revealed that certain loose equipment may probably interfere with the free movement of the control columns mainly due to the fact that the distance between the columns and the cockpit walls varies with the position of the columns.

The most likely loose equipment in question are the hand microphone, the torch light, the route manual and the balance computor or, for instance, a Coca Cola bottle

The result of a blocking is in most cases that the columns cannot be moved further back than to neutral or slightly nose down position. This will constitute a serious situation, especially at a low altitude when time for localizing the blocking is short.

Although the investigation of the wreckage revealed no indication of such a blocking, this possibility cannot be fully excluded.

On the basis of the previous sections it can be stated that the aircraft was duly certified and loaded according to valid regulations. No serious technical defect was known to exist at the time of departure from Istanbul.

It has been established with great certainty that Capt. Retvedt and the cockpit crew were in good physical condition and well suited to perform the flight at the time of takeoff from Istanbul. They had all valid licences and had gone through and maintained the prescribed training program. It has further been established that Capt. Retvedt was at the controls and that Officer Henriksson acted as copilot and handled the VHF communication. First Officer Finnevolden was the third crew member.

The basic material for the planning of the flight was satisfactory and the weather en route constituted no problem. The choice of flight path was no problem and no difficulties were expected between Istanbul and ANK range station. On the other hand certain difficulties were expected as regards landing weather at ANK, especially concerning the expected ground wind at the time of landing. The captain did also show great interest in this part of the flight planning and it is evident that he was quite aware of the forecast weather situation.

The flight between IST and ANK range station had surely been quite normal and only on two occasions was it necessary for the pilot to make small deviations from the best flight path. In the first case he had to climb higher than the minimum altitude for the climb out of IST and in the second case, the descent towards ANK was delayed. On both occasions other traffic interfered.

Radio communication with IST was normal and it has been ascertained that this was also the case with the radio communication with ANK.

The navigation conditions were good and the aircraft could be navigated without difficulty to a point over ANK range station.

This Danish Accident Investigation Report will be concluded in a subsequent issue of AVIATION WEEK.

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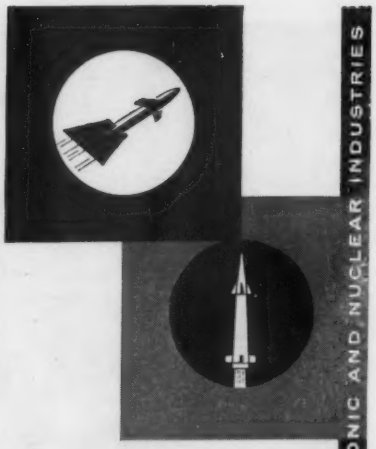

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12 Bausch Street, Rochester 2, N. Y.

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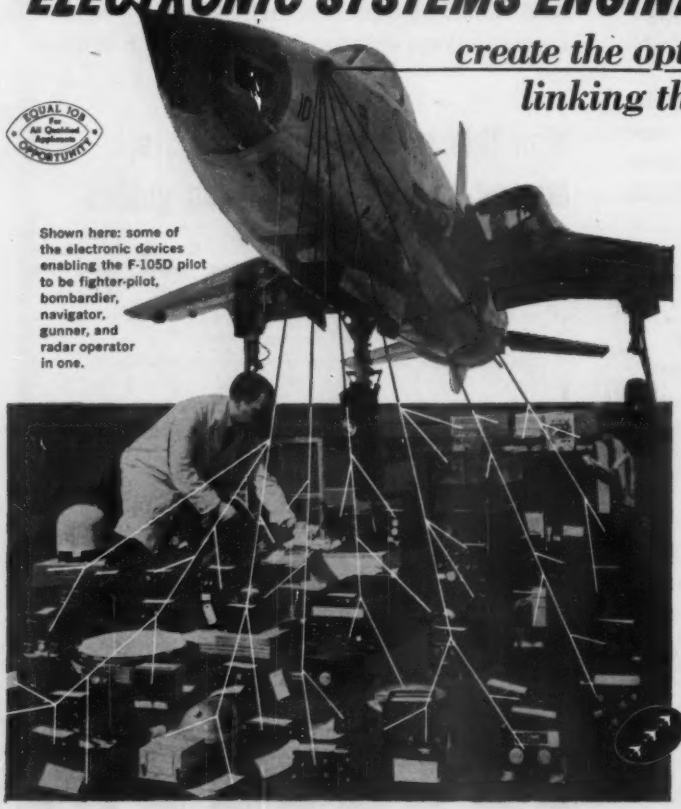
ELECTRONIC SYSTEMS ENGINEERS...

create the optimum neuro-pattern linking the electronic "brains" of Republic's F-105D



EQUAL JOB OPPORTUNITY For All Qualified Applicants

Shown here: some of the electronic devices enabling the F-105D pilot to be fighter-pilot, bombardier, navigator, gunner, and radar operator in one.

This revolutionary aircraft, the most fully automatic one-man fighter-bomber yet conceived, incorporates the most complete and sophisticated array of electronic systems ever assembled in one aircraft.

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- Fire control systems
- Flight control systems
- Infrared systems
- Digital computer design
- Analog computer design
- High speed tape recorders
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- Data link
- Navigation — doppler & inertial
- Communications
- Servomechanisms

If you have an EE or Physics degree and 5 or more years experience in one of the above areas, we invite you to write in confidence to:
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REPUBLIC AVIATION

Farmingdale, Long Island, New York

This four-cryotron flip-flop can be switched in *two billionths of a second.* It was developed by an IBM team investigating the possibilities of low-temperature devices for basic binary storage in digital computers.

IBM scientists and engineers designed the flip-flop around a primary law of low-temperature physics: A superconductive metal loses its superconductivity in the presence of a magnetic field. In the IBM device, a small control current is used to destroy the superconductivity of one of two parallel lines. This sets up a resistance in the first line and causes current to switch to the second.

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IBM Corporation, Dept. 524D3
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New York 22, New York

IBM

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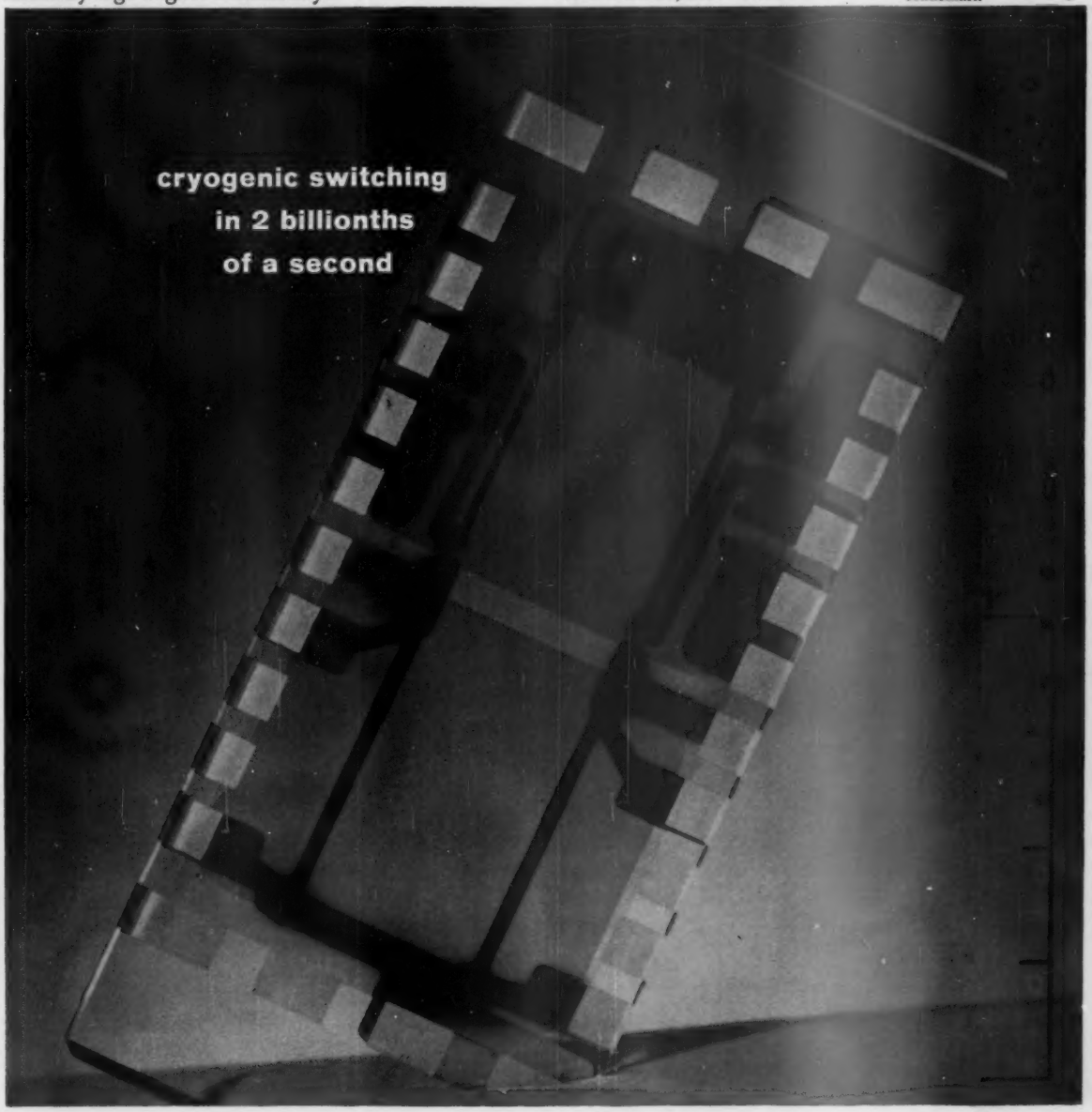

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Openings in technological fields include rocket, non-conventional propulsion techniques; air, sea and industrial nuclear power; navigation, guidance, communication and control systems; computers; industrial and military electronic components; detection, surveillance display, and countermeasure equipment.

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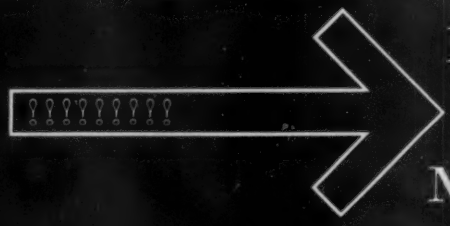

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TRiangle 7-7154

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For Sale—Howard Super Ventura. One year since manufacture. FS-5963, Aviation Week.

For Sale—Executive Dehavilland Dove. Low time—All mods complete—New Interior—Exterior. FS-5962, Aviation Week.

DC-3 Corp. owned 1350 HP P&W 1830-94 Engines Dual 360 comm., dual Collins omnis & R.M.I.s, C-4 gyrosyn, Sperry A-3 Auto-Pilot. Fuel Flow meters, new boots, tires, fabric, cockpit panelling, seats 22, gross 26,200 will gross 26,900 with rubber mod. $85,000. Will demonstrate Eastern U.S. GI 4-2192 P.O. Box 113, Ridgewood, N. J.

For Sale—two C-46s, Navy Configuration, complete with radio, ready to go $25,000 for both or sell separately. No letters. N. A. Kalt, CA 4-8434 San Antonio, Texas.

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Bids: May 5, 1961

Notice of Foreclosure Sale

IN THE UNITED STATES DISTRICT COURT FOR THE SOUTHERN DISTRICT OF FLORIDA

MIAMI DIVISION
No. 7868-M-Civil

AVIATION CREDIT CORPORATION,
Plaintiff,

vs.

UNITED STATES OF AMERICA, RALPH DELGADO, CONNER AIR LINES, INC., F. A. CONNER and JOSEPH G. MORETTI,
Defendants.

NOTICE IS HEREBY GIVEN, pursuant to a final decree of foreclosure entered in the above-entitled action on February 13, 1961 and a supplemental order entered March 30, 1961, that I will sell at public auction, for cash, to the highest and best bidder, at the South door of the Federal Building, 300 N. E. First Avenue, Miami, Florida, at 11 o'clock in the morning of May 5, 1961, the following described property set forth in said final decree, to wit:

Douglas DC-6 (YC112A) Aircraft, Mfrs. Serial No. 36326, together with equipment and accessories therein, exclusive of engines;

Four (4) Pratt & Whitney R2800-34 Aircraft Engines, bearing Mfrs. Serial Nos. P-51598, P-24169, P-54986 and P-51599, with Curtiss electric propellers;

subject to confirmation by the above-styled Court. Dated at Miami, Florida, this March 31, 1961.

G. HUGO WHITEHOUSE, as
Special Master
501 Ingraham Building
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LETTERS

Baggage Liability

Periodically, in Letters to the Editor, attention is drawn in this age of jet transportation to some of the absurd situations which are permitted to exist in airline customer service.

One of these, concerning the difficulty of obtaining simple efficient transportation between terminals at Idlewild, appeared under the heading "Airline Odyssey" in your issue of Nov. 7, 1960 (p. 146). I almost wrote a fervent "amen" to that letter.

I wish to bring to your attention another situation in which the passenger's convenience is given second place. It is in the handling of baggage on which the passenger places a valuation greater than that to which the carrier normally limits his liability.

During over 20 years of traveling by air in which I have traveled the best part of half a million miles, I have had the normal number of experiences with lost baggage. In all but the last case, the missing baggage turned up within a few days. On Dec. 11, 1960, I left Orlando, Fla., on National Airlines intending to transfer to Eastern at Washington, D. C., for Syracuse, N.Y. That was the night of a big snow storm on the East Coast. After the takeoff was delayed for two hours at Orlando, the National flight overflew Washington and arrived nonstop at Idlewild. Normally, I do not leave the airport until I have claimed my baggage or have learned that it did not arrive on the same flight. This night after waiting over an hour for my bag, I learned that the baggage compartment doors were stuck or frozen shut and that "it might take five minutes or five hours" to unload the bags. I have not seen my suitcase since.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

The efforts which National exerted to find my suitcase were routine, consisting principally of waiting for it to turn up. In due course, I was offered a check for $100 which is National's maximum liability "under our tariff regulations on file with the Civil Aeronautics Board." ($100 is far below the value of my suitcase, two suits, etc.)

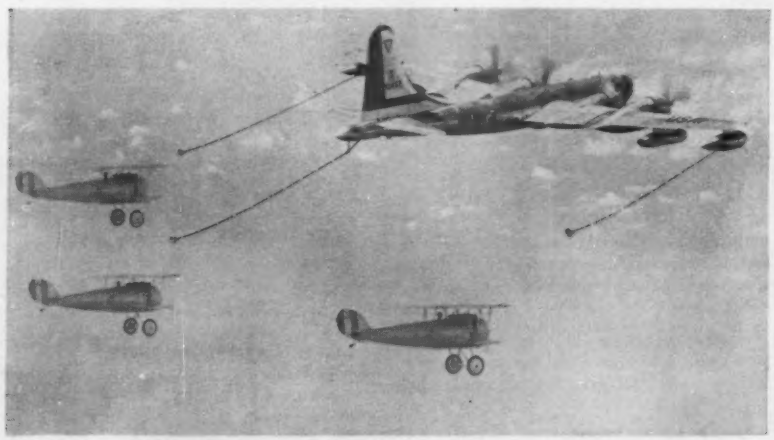
Of course, I was advised to declare a higher valuation and pay the normal charge in the future to protect myself against a similar loss.

Now consider what happened when I declared a higher valuation on my baggage on a trip with the same itinerary—National from Orlando to Washington, and Eastern from Washington to Syracuse. National cannot transfer the bag to Eastern (or to any other airline) when a valuation over $100 is declared and the appropriate tariff is paid, but can only return it to me. Eastern supported this position. Apparently this same rule applies to all airlines.

As National is located in the North Terminal at Washington and Eastern is in the Main Terminal, I was forced to carry the bag or to pay a skycap to do so. When I arrived at Washington, the baggage from four flights was being unloaded simultaneously. Competition for skycaps was very keen. The National flight was late and I had barely 15 min. to make the Eastern connection. To divert a skycap from the rush business of taking bags to the taxi stand, it was necessary to offer him $2 to rush my bag to the Eastern counter. I should point out that a sore back prevented me from carrying my bag on this trip.

You undoubtedly recall the advertisements placed by R. R. Young a few years ago when he was attempting to get through-passenger service from coast to coast on trains. The advertisements announced that a hog could travel from coast to coast without changing cars, but a person could not. The same type of situation prevails here. I can send a package as airfreight or air express and insure it from origin to destination, regardless of the number of airlines involved, but I cannot do the same with my personal baggage if it is carried as part of the transportation covered by my ticket! This is ridiculous.

H. B. Hoeper
Eau Gallie, Fla.



Aerial Refueling–TAC's Next Fighter?

TAC's follow-on fighter bomber designed to meet U. S. Army ground support requirements currently projected in published news articles quoting Army strategists.

(The above picture and caption were submitted to Aviation Week by a USAF public relations officer. Fighter aircraft are French built Nieuport 28's of the 94th Pursuit Squadron 1st Pursuit Group AEF, the tanker is a KB-50 of Tactical Air Command. We reproduce this material without comment as a contribution to interservice rivalry in humor—an ingredient that the Pentagon lacks in usable quantities.—Ed.)

Booster Systems

Reference: "The Stern Chase in Space," Aviation Week, Feb. 20, p. 21.

Your editorial of Feb. 20 gives a perspective of the importance booster power will have in this decade.

But it is not so clear that only larger booster propulsion systems are required to put adequate tonnage into orbit and also at greater distances from the earth.

There is also no real evidence that the Russians are using larger rocket engines. This would be quite against their mentality employing the simple way of approach. What they may do is to use their available rocket power more efficiently.

The present day booster operates as a vertical takeoff system and a thrust of approximately 1.3 times the gross weight is required to lift and accelerate the vehicle. To give a specific example: a 500,000 lb. booster vehicle needs a rocket engine of 650,000 lb. thrust.

System studies have shown that only a thrust of 0.6 times gross weight would be needed to accelerate a vehicle in a horizontal takeoff.

For the specific example, this would result in a required rocket engine thrust of 300,000 lb. only. Considering structure penalties approximately 55% of engine thrust is required to get the same payload into orbit.

With respect to a payload increase, there is still an additional improvement possible by using an air breathing booster system for the first stage; operating with a specific impulse of approximately 1,200 sec. would considerably contribute to the economy of the future space traffic. Certainly, the entire booster program should be thoroughly examined.

Dr. M. Gerloff
Philadelphia, Pa.

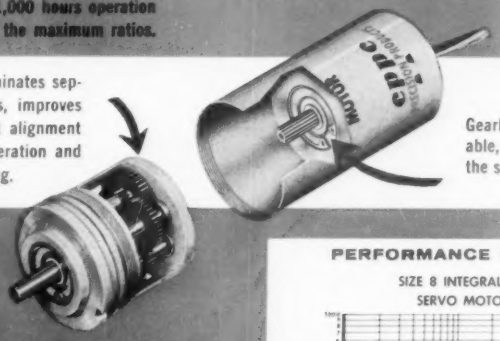
NEW SIZE 8 INTEGRAL GEARHEAD MOTORS

3 Times Torque Load Capacity*

of comparable size 8 gearheads

*Will sustain 20 in-oz torque load for 1,000 hours operation and 100 in-oz momentary overload at the maximum ratios.

CPPC one-piece gearhead housing eliminates separate gear plates and fastening posts, improves and maintains accuracy through exact alignment of gear clusters, assures smoother operation and more expedient inspection and servicing.



Gearhead and motor are selectable, individual parts enclosed in the same common motor housing.

Clifton Precision, pioneers in postless gearhead construction, introduces the finest in gearhead design—cage-type, one-piece gearhead housing machined from a single block of metal. In these units, exact duplication of gear centers is accomplished through simultaneous boring of permanently integrated bearing plates (patent pending). Positive and permanent alignment of gear clusters composed of AGMA precision Classes II and III hardened-steel gears integral with shafts journaled at both ends in ABEC class 5 bearings, minimize deflection and backlash, maximize torque load capacity, insure smoother operation and continued reliability of performance beyond normal endurance life requirements. Cage-type construction facilitates inspection and lubrication while gearhead is mounted simply by removing motor.

CPPC motors will stand greater heat than ever before due to the use of new materials. See box at lower right.

Write for our free pamphlet which gives detailed specifications of our entire gearhead motor and motor-tachometer line, sizes 8, 10 and 11.

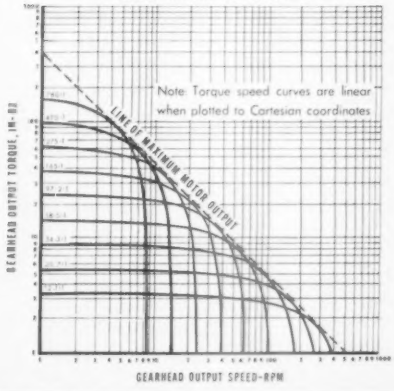
STANDARD TYPES

RATIOS		No. of	Dir. of
Size 8	Size 10	Clusters	Rotation
12.09	19.98	2 (3 pass)	reverse
20.63	32.19	3 (4 pass)	direct
34.26	58.28	3 (4 pass)	direct
58.44	93.89	4 (5 pass)	reverse
97.07	169.97	4 (5 pass)	reverse
165.58	273.84	5 (6 pass)	direct
275.02	495.74	5 (6 pass)	direct
469.15	798.70	6 (7 pass)	reverse
779.22	1445.92	6 (7 pass)	reverse

Notes: 1. Any ratio (±3%) is available within the limits of the ratio range at additional cost and may require longer delivery time. 2. Max. backlash = 30 minutes at 2 in-oz reverse gauge load in above units. Inquire if special tolerance is required.

PERFORMANCE CHARACTERISTICS

SIZE 8 INTEGRAL GEARHEAD MOTOR
SERVO MOTOR TYPE ALC-8-□-1


Note: Torque speed curves are linear when plotted to Cartesian coordinates
LINE OF MAXIMUM MOTOR OUTPUT
GEARHEAD OUTPUT TORQUE, IN-OZ
GEARHEAD OUTPUT SPEED-RPM

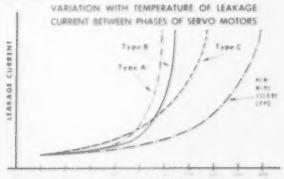
MOTORS

The following CPPC standard motors, electrical characteristics of which can be found in the current CPPC Rotary Components catalog, are offered with our gearheads:

SIZE 8		SIZE 10	
ACH-8-□-1	AMH-8-□-3	ACH-10-□-1	ALH-10-□-1
ACH-8-□-4	ALC-8-□-1	ACH-10-□-4	ALH-10-□-5
AMH-8-□-1	ALC-8-□-4		

CURRENT LEAKAGE

Superiority of insulation in CPPC motors is illustrated by actual comparative curves shown at the right.



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CLIFTON HEIGHTS, PENNSYLVANIA

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UNIVERSITY MICROFILM INC
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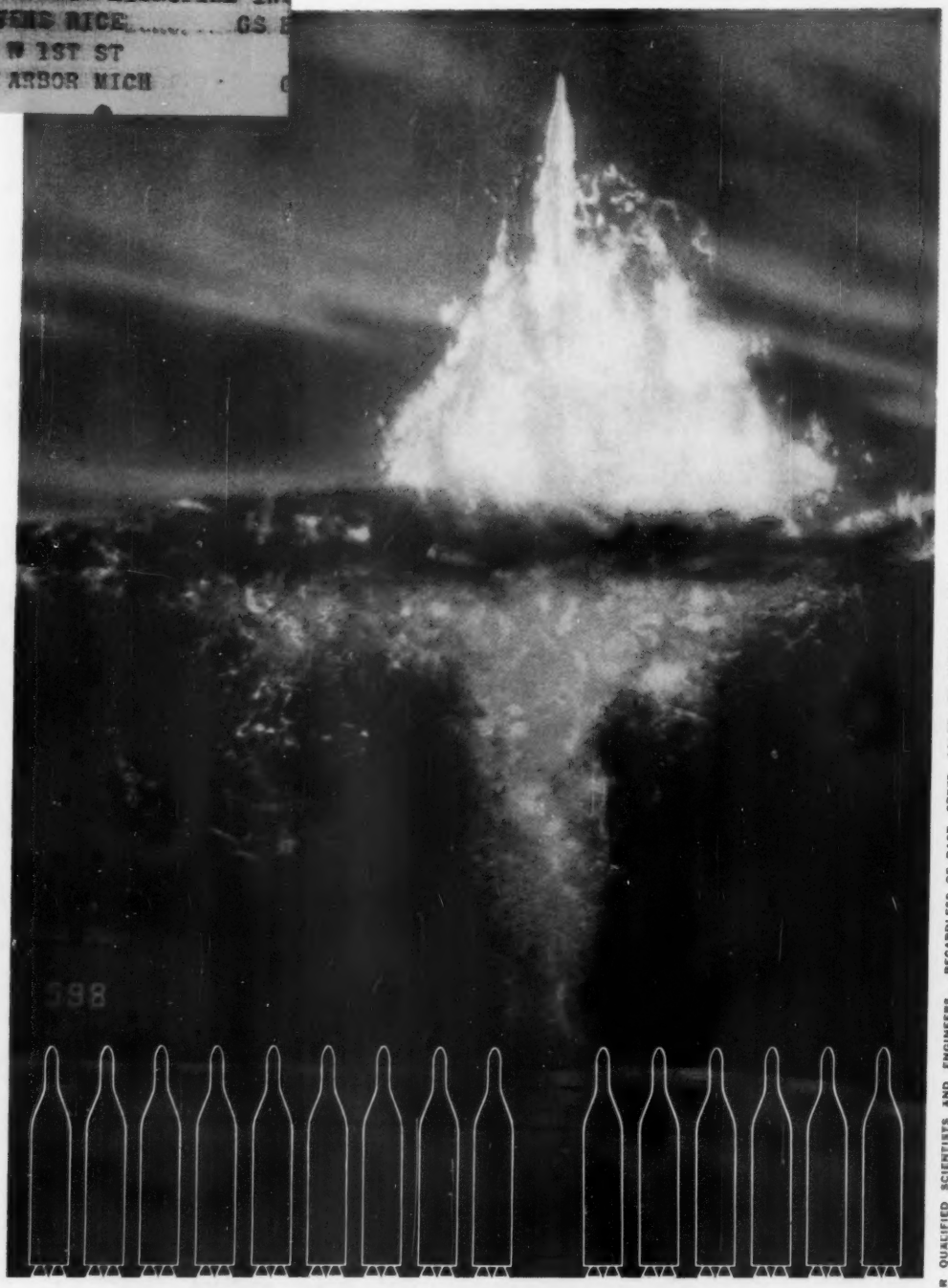

Priming the Polaris missile. Now on duty, or shortly to be, are the nuclear submarines George Washington, Patrick Henry, Robert E. Lee, Theodore Roosevelt, and Abraham Lincoln. Their mission: deterrence. Aboard each sub, giving muscle to the mission, will be sixteen Polaris missiles. These missiles are armed and fuzed by Avco's Electronics and Ordnance Division, working as a team with the Naval Ordnance Laboratory.

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